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FUEL CONSERVATION IN BRITAIN

IN recent years two subjects have been constantly before the British public to such an extent that a state of saturation has been reached and the people have become almost indifferent to incessant exhortation. One is productivity and the other is fuel. In some respects they are both as important to our welfare as the air we breathe. Indeed, the air itself has recently come into the orbit of popular clamour as the result of the unfortunate occurrences that followed an atmospheric inversion in December last. All these matters are linked up with fuel conservation, the subject of a recent brochure published by the British Productivity Council and addressed to the Anglo-American Council on Productivity*. The publication, a somewhat detailed document of more than one hundred pages, is a report on a visit made to the United States in January of last year by a British team to study the conservation of fuel, heat and energy in the United States of America. This visit was planned with the view of improving the efficiency of fuel utilization in British industry, and indicating ways and means by which a national fuel policy might be developed.

The report contains much interesting material, for example, in relation to such matters as the comparison of the fuel resources in the United States and Great Britain, the relationship between energy and man-power, the high rate of consumption of power per head of population in comparison with that in Britain, associated to some degree with the high costs of labour in the United States, combined heat and power supply, so-called 'packaged' boilers, the six hundred heat pumps installed in thirty-nine American States, and the measures taken by the Americans to attempt to control their smoke emission. In general, however, the major substance of the report has been well known for at least a decade, and in some respects for a generation. Accordingly, the mischievous critic might be tempted to suggest that the report could have been written without the visit to the United States having been undertaken. Nevertheless, the authors deserve commendation for a painstaking review, and not the least for the clear and concise summary and recommendations, much to be welcomed in these days when the scientist and the industrialist have so much to read in order to keep abreast of modern developments. Many of the recommendations should receive general support; but others are open to criticism mainly for the reason that, though they may state desirable objectives, they give little information that is new which would enable these objectives to be achieved. Thus there is a plea for the removal of the nationalized industries from the influence of party politics, but no practicable suggestions as to how it may be done. Again, there is a call for co-ordination of the coal, gas and electrical industries by a directive composed of

* British Productivity Council. Productivity Report: Fuel Conservation. Report of a visit to the U.S.A. in 1952 of a Specialist Team on the Conservation of Fuel, Heat and Energy. Pp. xii+102+8 plates. (London: British Productivity Council; Washington, D.C.: Office of Technical Services, Department of Commerce, 1953.) 5s.

"men best fitted for the job". This phrase may be interpreted by various types of opinion, as meaning 'jobs for the boys', or 'overlords', or 'suitability based on experience and achievement'. The recommendations also call for a government statement on policy. Policy may be interpreted as the motives that govern administrative action, and therefore must be essentially a matter of day-to-day concern. One cannot expect, therefore, a wise administrator to be other than cautious in stating policy in advance; and least of all to put important administrative functions in the hands, say, of a commission as recommended in the report. The larger the organization the less efficient it must become, since human relations depend upon human beings, and there is approached that state of society envisaged by Wells, in which man becomes the slave of the machine he has created.

The reference to financial incentives in the form of tax relief, rather than loans, should in our opinion have had pride of place. Indeed, it is the only recommendation that could have any real effect in furthering fuel efficiency in those branches of British industry in which the cost of fuel is a secondary matter.

It is well known that where fuel is an important factor in costs of production, considerable attention is given to fuel practice. This feature of the problem has been overlooked in the report, as well as the remarkable contributions to fuel efficiency that have been made in these industries during the past generation. Indeed, in reading the report, the newcomer to the subject is almost left with the impression that fuel efficiency began with the Ridley Report. The real progress in these matters is made by those sections of industry and industrial and scientific research, the business of which it is to advance technical practice. Thus we have seen, during the past thirty years, considerable progress in the fuel aspects of the production of power, the manufacture of iron and steel, and the development of a whole host of new industries based on the by-products of coal, all having had outstanding results, not only in increasing world productivity but also in saving British coal. Arguments in committee, exhortation, publicity and even the best of salesmanship can be of small account in these matters in comparison with a major advance in practice based on scientific discovery, or even with the day-to-day efforts of the technologist or engineer concerned with such practice.

The problems discussed in the report are, however, of a sociological rather than a technical character, in so far as any effective action is concerned. Nevertheless, the general reader will be interested in much of the technical matter discussed. Thus the discussion of the development of dual-generating stations located in industrial areas is timely. There are pages of much interest on the more well-worn subjects of the developments to be looked for in the gas industry, the improvement of the education and status of stokers, the thermal insulation of buildings, the greater use of instruments and smoke abatement. Some controversial issues are raised in regard to the standardization and design of boilers. Whether the American model of the self-contained, automatically controlled oil-fired boiler of the 'packaged' pattern will meet needs where ostensibly the inferior grades of coal may be efficiently used is open to question. There is also a tilt at the railways of Britain in regard to the use of large coal for firing locomotives. This is thought to be a traditional practice rather than a rational one, and it is recommended that the judicious use of sized coal would be both desirable and useful. The last recommendation recalls a particularly British failing in all but the largest and most progressive elements of industry, namely, the gap between the production and application of a new discovery. This statement has been made time and time again; but progress is very slow. No new suggestion, however, emerges in the present juncture. Summing up, while the report may contain little that technical workers do not already know, it presents these topics in general terms which may help to bring them before the public and so prepare the ground for action.

PRECISION IN ASTROPHYSICS

The Outer Layers of a Star

By Prof. R. v. d. R. Woolley and D. W. N. Stibbs. (International Series of Monographs on Physics.) Pp. xi+307. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 40*s*. net.

Basic Methods in Transfer Problems

Radiative Equilibrium and Neutron Diffusion. By V. Kourganoff, with the collaboration of I. W. Busbridge. (International Series of Monographs on Physics.) Pp. xv+282. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 35*s*. net.

THE greater part of what is known about the sizes, masses and motions of the stars, about what goes on in their interiors and also about the diffuse matter outside them depends upon the detailed investigation of the radiation that the stars emit. All the features of this radiation are influenced by the processes occurring in the outer layers of the stars. Recalling these familiar facts, it is appreciated that any precision in our knowledge of the astronomical universe is to a major extent conditioned by the precision of our knowledge of the processes mentioned and of the parts they play in affecting anything that comes out of a star. The two books under review are concerned with these matters, that is, with the chief basis of precision in astrophysics. Thus there is ample justification for the elaboration in the treatments they present. To such justification must be added that of the inherent interest of the work itself.

The work is also of interest for physics in general and not only for astrophysics. As an example (outside the scope of these books) it may be mentioned that one of the three 'crucial tests' of Einstein's general relativity theory is concerned with the gravitational red-shifts of spectral lines. Despite past claims, it is now widely recognized that this matter is not yet settled and that it cannot be settled at the present stage of astrophysics. All the other agencies that affect the spectral lines can be assessed with sufficient accuracy to admit the application of Einstein's test only, if at all, after even greater

elaboration of the astrophysical theory than that exemplified in these books.

With regard to "The Outer Layers of a Star" by Prof. R. v. d. R. Woolley and D. W. N. Stibbs, it is a pleasure to welcome a book from the Commonwealth Observatory of Australia, which, under Prof. Woolley's direction, has so rapidly become a leading centre of astronomical research. The topics dealt with include many to which Woolley himself has made numerous important contributions. The range of topics, mathematical and physical as well as astronomical, is exceedingly extensive, and the authors have selected them for varied reasons concerned with importance, with adaptation to astrophysical requirements, with bringing other accounts up to date (to 1950), and, very naturally, with their own particular interests. The common factor of all the work is its usefulness for further progress in the subject. Every item is the sort of thing that a working astrophysicist may need to know about at any moment, and he will be grateful to be able to turn to Woolley and Stibbs for a clear and concise account of it.

The main part of the book deals with the mathematical and physical theory of the transmission of radiation through a stellar atmosphere in radiative equilibrium. Chapter 9, on the photosphere, turns to problems in which mechanical equilibrium is also concerned, and these are further pursued in Chapter 10 on convection. Chapters 11 and 12 deal with the outermost regions of the solar atmosphere and, among other things, are noteworthy for giving probably the first 'text-book' account of the escape of radio radiation from a star. Most of the observations with which the theory is compared thus far are those for the sun; a final chapter deals with stars other than the sun. One regrets that it does not include a table of, say, temperatures, densities and linear depths (so far as these have been evaluated) for various optical depths for stars of various classes; the available information is often asked for, but appears not to have been collated in any standard text.

Many readers may be surprised to know that the exact solution in calculable form of the simplest significant problem of radiative transfer has been obtained completely only within about the past ten years. The problem concerns the transmission of radiation through a highly idealized atmosphere and was formulated by E. A. Milne more than thirty years ago. Moreover, until the exact solution was available, there were no reliable estimates of the accuracy of the various approximate solutions. The chief purpose of Dr. V. Kourganoff's book is to describe all the methods so far discovered for obtaining approximate and exact solutions of this one problem. As he says, this serves to illustrate most of the essential difficulties of the subject. Also, the methods form the basis for the solution of more general problems, and some ways in which they have been made to do so are summarized in the concluding chapter.

Dr. Kourganoff has contributed much to the theory which he here presents in such a well-digested form and with such illuminating insight. Clearly, Dr. I. W. Busbridge's collaboration has added substantially to the many merits of the book. To those whose primary interest is in transfer problems (of radiation or of neutrons) it will become indispensable. Its reading is also to be strongly recommended to those beginning research in theoretical astrophysics: in a subject where so much has to be attempted by the use of somewhat crude mathematics, this would be an excellent remedial exercise.

At the same time, those who do try to make progress by the cruder methods may seize the occasion to point to this book as illustrating the formidableness of the difficulties in using more refined mathematics for even the simplest of their problems.

The main part of the book is an exhaustive treatment of the theory outlined in the first three chapters of Woolley and Stibbs, which ought to be read first. Dr. Kourganoff's book is complementary to Chandrasekhar's "Radiative Transfer" (1950), as might be expected from its inclusion in the same series of monographs. In the latter book a smaller range of methods is applied to a much wider range of problems. The non-glossy paper used for the present volume makes it much pleasanter to read than some others in the series.

W. H. McCrea

STATISTICAL METHOD IN BIOLOGICAL ASSAY

Statistical Method in Biological Assay

By Dr. D. J. Finney. Pp. xix+661. (London: Charles Griffin and Co., Ltd., 1952.) 68*s*. net.

THIS is the most comprehensive text-book which has so far appeared on statistical method in biological assay. Like all true scholars, Dr. Finney has endeavoured to give a thorough account of a particular branch of human knowledge. "My aim", he says modestly, "has been to develop the theory and methods as far as seem practicable at this time, and to show the unity of the various aspects of the subject", but the driving force behind the production of this able exposition is a great deal more than utilitarian. This explains its success. The book is written primarily for professional statisticians who wish to acquire a comprehensive knowledge of the subject; but it is intended also for use by four different categories of readers: the professional statistician desiring a short course in biological assay, the non-mathematical user of biological assays, the reader whether statistician, biologist or chemist who requires a general survey of the function of statistical science in biological assay, and the reader whose interest lies almost entirely in assays based on quantal responses. Suggestions are made for a first reading by each class.

After an introductory chapter dealing with the purpose, history and structure of biological assays and the role of international standards and statistical science in relation to them, direct assays are next discussed. In direct assays the amount of the drug under examination necessary to produce the characteristic response is observed directly in each animal used. The rest of the book deals with assays depending on measured responses (fourteen chapters) and on quantal responses (five chapters). The treatment is thorough with special attention to general principles and with copious well-chosen examples. The importance of statistical design is rightly emphasized.

The fourth, fifth and sixth chapters deal with parallel line assays and their efficiency, reliability and sensitivity. The seventh and eighth are concerned with slope-ratio assays. They are particularly good, and a tribute must be paid to the author here

for the great part which his own work has played in the development of this part of the subject. There follow chapters on incomplete block designs, cross-over designs, multiple assays, the use of concomitant information, composite responses, the combination of estimates, and then the validity and choice of metameters. The sixteenth chapter is concerned with an illustration of a general method which can be used when the transformation which produces equality of variance in response at all dosage levels fails to produce a linear dosage response relation.

In considering assays based on quantal responses, the author first considers, in a general way, the various transformations which might be employed to produce a linear dosage-response relation, and then shows how the computations are carried out. The principles of good design are then discussed and found to be very similar to those for parallel line assays based upon quantitative responses. A chapter is devoted to a number of alternative but less exact methods which have been proposed in order to avoid the iterative calculations of the maximum likelihood solution. Then follows a chapter on some special problems with quantal responses; the treatment of estimates of the density of a bacterial suspension from a dilution series is particularly valuable. The work concludes with a short discussion of the use of time as a response. There are more than two hundred and fifty references, and seventeen useful tables for assisting computation.

In the subject of biological assay there are some matters which may still be considered controversial, or unsettled. Such points are the precise conditions under which limits of error can accurately be called 'fiducial', and under which the Fisher–Behrens distribution can be regarded as exact; the relative merits of the logistic and integrated normal distributions as conceptual models for tolerance distributions, and of maximum likelihood and minimum χ^2 solutions; the correct way of combining estimates from assays of different type; and the extent to which efficient but laborious methods of estimation can be replaced by methods less efficient but easier to calculate. When the author discusses these topics he is always fair.

In one of the early chapters a valuable distinction is made between *comparative* and *analytical* dilution assays. "In many assays the test preparation behaves as though it were simply a dilution (or a concentration) of the standard preparation in a diluent that is completely inert in respect of the response used . . . Assays in current use . . . are almost all either strictly or approximately *dilution assays*, to which category the theory and methods of this book are restricted. In some assays there may be strong reasons for believing that all constituents of the test preparation other than one are without effect on the response of the subjects. An assay of the preparation against a standard preparation of the effective constituent is then equivalent to an analysis for determining its content of the constituent: this may be described as an *analytical dilution assay*. In other circumstances the two preparations may for assay purposes behave as though qualitatively the same in effective constituents, though in fact they are not the same; the statistical methods appropriate to analytical assays may still be useful for arriving at convenient summaries of results, but such a *comparative dilution assay* is of more limited value as a basis of inference. . . .

"The results of such a *comparative dilution assay* need not have any validity under conditions other than those of its estimation. In an *analytical dilution assay* on the other hand the estimate of potency should be independent of the assay technique employed, and should agree with a process (perhaps chemical or physical) not using bioassay. The choice of subject, response, and experimental conditions should be irrelevant to the estimate that is formed, except in so far as they affect the precision of estimation."

The wide development of the technique of biological assay arose out of assays against international standards. There is a curious paradox here. Such assays are always intended to be *analytical assays*, but this is seldom completely true. With vitamin A, for example, the object is (or was) to determine the amount of vitamin A per gram in a preparation (say a cod-liver oil), but as the physical properties and chemical composition of vitamin A became known, the biological assay gradually became less and less necessary. To-day, vitamin A is, in fact, always assayed spectrophotometrically. The biological assay of digitalis is not strictly an analytical assay, for digitalis is a mixture of several different chemical compounds. When it becomes practicable to assay these separately biologically, it may well be unnecessary to do so. In general the more nearly a biological assay approaches to the ideal of an *analytical assay* the less necessary it becomes. When the ideal is reached the purpose of the assay is usually achieved. However, new biological standards are constantly being set up, so that the self-extinction of this branch of the subject, to use Sir Henry Dale's phrase, seems as far off as ever. Further, the number of possibilities for application of the technique of comparative dilution assays seems always to be increasing. So there is no fear of lack of new problems to which the fascinating statistical techniques, so ably described in this book, may be applied.

J. O. Irwin

PHOTOELASTICITY AND ENGINEERING DESIGN

Designing by Photoelasticity

By Dr. R. B. Heywood. Pp. xvi+414+22 plates. (London: Chapman and Hall, Ltd., 1952.) 65*s*. net.

DR. HEYWOOD has drawn on the extensive experience of the photoelastic method of stress analysis he has gained while working in the Research Department of Rolls-Royce, Ltd., and in government service to present his views on "Designing by Photoelasticity".

The title of the book, suggesting as it does that one can design engineering components or structures by photoelasticity, may prove misleading to the uninitiated. Photoelasticity, like all the other methods of experimental stress analysis, is not a method of design; it is a method of analysis. It is not a creative but an analytical activity. Photoelastic stress analysis can only be carried out on a proposed design. Given such a design, photoelastic analysis can discover its weaknesses, and this information may or may not lead to a better design. The reviewer would wish to be the last person to belittle the importance of photoelasticity as an aid to design—it is probably the most powerful

tool at present available for the determination of stress concentration factors—but no useful purpose is served by implying that it can do what it is inherently unfitted to do.

The author addresses his book both to photoelasticians and to engineers, and the book is divided into two parts. Part 1, which occupies about one-third of the length of the book, deals with some of the fundamentals of optics which are relevant to the photoelastic method of stress analysis, with the properties of photoelastic model materials, with the preparation of models and the necessary precautions which should be observed if models are to be loaded accurately, and with the validity of the transfer of information gained from a model made of a transparent plastic to a prototype of mild steel or light alloy. This section also deals with the 'frozen stress' technique used in the analysis of three-dimensional stress problems, giving a considerable amount of practical information.

Part 2 is devoted to the discussion of information derived from photoelastic data and from theoretical and empirical work by the author and others on stress concentrations caused by notches and holes. One chapter deals with stress concentrations in screw threads, bolts and nuts, while in another, improvements in the design of components are discussed which were obtained by paying attention to geometrical details, such as the radii of fillets, after the original design had been shown to be unsatisfactory by photoelastic investigations. The final chapter of the book is devoted to the application of stress concentration factors, their use in problems where fatigue is an important consideration and the effects of size on the applicability of these factors. The book is well illustrated and is completed by an extensive bibliography which, although it does not claim to be exhaustive, should prove most useful to workers in this field.

Some of Dr. Heywood's more dogmatic statements on photoelastic equipment and methods are not likely to meet with the agreement of all photoelasticians; but he undoubtedly deserves credit for collecting together within the confines of one book a great deal of information from a wide variety of scattered sources which should prove useful to engineering designers.

E. K. Frankl

NATURAL HISTORY OF INFECTIOUS DISEASE

Natural History of Infectious Disease

By Sir Macfarlane Burnet. Second edition. Pp. x + 356. (Cambridge: At the University Press, 1953.) 22*s*. 6*d*. net.

THE author of this book is not only himself a most distinguished research worker, but also he has perfected a method of presenting in a clear, palatable and most intelligible manner the natural history of infectious diseases. He treats them as a good naturalist should, when writing on his favourite subject, with regard to their place in Nature, their likes and preferences, methods of dissemination, their social background; in fact, all which may be termed, for a better word, their 'ecology'.

It is possible to regard the middle of the twentieth century as the end of the most important social revolution in history, the virtual elimination of infectious disease as a significant factor in human affairs. Could we be similarly assured of the abolition of war, we could feel confident of eternal peace and progress with the extinction of epidemics and a reduction of illness to mere trivialities.

Along with this has gone a steadily increasing interest in the morphology and characteristics of the responsible micro-organisms. Every animal species reproduces its kind at a far greater rate than is necessary to maintain its numbers.

Limiting factors are always present and the maintenance of a species can be regarded as the result of conflict between two opposing forces—what is known as the 'population pressure'. As an illustration the lesson of the introduced domestic mouse in Australia is cited. In certain years these creatures swarm in crops and haystacks, so that bucketfuls may be caught in a single night. Hawks, owls and cats gorge on them, while birds, like ibises, change their normal diet; and then, the plague ends suddenly. A few dead corpses litter the ground, and the numbers dwindle to below normal. Some infectious disease, such as *Streptobacillus moniliformis*, has been at work and has done what none of the predators could accomplish. How far can this lesson be applied to man? How comes it that all dwellers in insanitary cities do not die of infectious disease? New parasites creep in like the Black Death and spread from city to city with rats and fleas; syphilis sweeps through Europe with the advance of conquering armies, but cholera spreads invisibly from carriers, as it did a hundred years ago.

The evolution of infection and defence is a fascinating subject which takes us back to Metchnikoff, toiling in his laboratory with all kinds of outlandish creatures, while studying the cellular reactions and phagocytes in *Daphnia*, the water flea; and then the aggressors—bacteria and protozoa—all pass before our view. We can envisage some of the stages by which the complex life-history of the sleeping-sickness trypanosome came into being, by studying the simple life-story of closely related forms. There is one trypanosome, for example, which infects the blood of lizards and is derived from a small biting fly by the simple process of being swallowed.

The viruses are more complex and much light has been shed upon their habits and appearance by the electron microscope since the first pictures were taken by these means in 1938. The smallest particles are those of poliomyelitis. The study of viruses has also been amplified beyond computation by their cultivation on the amniotic cavity, the chorioallantoic membrane, the alimentary cavity and yolk sac of the domestic egg. It is explained, too, how much may be learned from contemplation of the many plant viruses which are of such great economic importance. This leads to a consideration of the rickettsiæ, which form a step between the virus of psittacosis and the smaller members of the group.

The processes of defence are much more involved, but by this master-hand are made readily intelligible to intelligent minds. Finally, we are given an outline of the conquest of some important diseases, such as diphtheria, influenza, tuberculosis, plague, cholera and of the epic of malaria. Yellow fever, too, makes grand and sensational reading.

Enough has been said to show that this book makes a deep appeal to the ardent searcher after knowledge, as well as providing pleasant bedside-reading for the practising physician.

P. Manson-Bahr

Unto the Fields

By D. W. Gillingham. Pp. 286. (London: Museum Press, Ltd., 1953.) 17*s*. 6*d*. net.

HERE, in this book, are the qualities—and how seldom they are found in conjunction—that go to the making of a good book about the English countryside; those qualities and some others. The author, as a child already sensitive both to beauty and cruelty, left a home in Leytonstone, while buttercups could still be gathered there, for Canada, where in boyhood his happiest years were spent. He returned nearly twenty years ago to much disillusionment. He has remained a Canadian in spirit, "with my roots left deep in the wide fellowship of the west". Yet, in spite of that loyalty and that disillusionment, he attributes to England "such beauty in her countryside as the rest of the world can but dream of".

Mr. Gillingham, it would seem, has devoted, since his return to that countryside, all his acute senses and most of his often scanty leisure to the development of a passionate sympathy, the more convincing by reason of a background of scientific knowledge and an awareness of history and pre-history, with the birds and beasts, the flowers and trees, the earth and the skies of a corner of Essex at the edge of London. He reports on the eve of war the advance of decay upon that beautiful place. He finds the more violent assaults of war-time upon it in some measure dignified by a sense of purpose. Returning from war service overseas, he recounts briefly and grimly its devastation by a London County Council housing estate.

Those who are capable of entering into so close and loving a communion with the earth and its creatures, as is here with a hundred vivid and delightful details recorded, are rare. Those who can also on the printed page bring alive to their fellows so passionate a sympathy are rarer yet. Mr. Gillingham combines the accurate observation and recording of things seen and heard with an imaginative outlook and a handsome command of the English tongue. An unusual and a rewarding book, well illustrated by Mr. Henry Pettit. Stephen Tallents

Annual Review of Biochemistry

J. Murray Luck (editor), Hubert S. Loring and Gordon Mackinney (associate editors). Vol. 20. Pp. x+648. Vol. 21. Pp. x+781. (Stanford, Calif.: Annual Reviews, Inc., 1952.) 6 dollars each.

THE "Annual Review of Biochemistry" was the first of many hardy annuals, and is now entering its third decennium. The editorial committee points out that it began with considerable confidence in the belief that the reviews would be critically written, but that sometimes unexpectedly a review, as received from the author, proves to be an assortment of abstracts, brief, terse and numerous—the result of a valiant effort to treat the literature comprehensively rather than selectively.

In the reviewer's opinion the majority of the articles in the two volumes under consideration are reasonably selective and are at the level of usefulness to be expected from the critical equipment of each individual author; but naturally there is variation from one article to another. Among subjects which do not qualify for annual review are "Biochemical Genetics", by N. H. Horowitz and H. K. Mitchell, and "The Metabolism of Drugs and Toxic Substances", by R. T. Williams; and "Chromatography", by S. Moore and W. H. Stein. The latter in particular is a valuable and critical appraisal of a field that is growing at once in importance and complexity.

"Biological Oxidations" is a subject considered annually and is usually given first place, as being of fundamental importance; though the lucid and authoritative review of this subject by Britton Chance and L. Smith in Vol. 21 is the last article in the book, this position may result not from a new attitude to the subject but from accidental causes.

The production is good and the indexes are excellent. The standard we have learned to expect from "Annual Reviews" is clearly maintained. F. G. Young

Many-valued Logics

By Prof. J. Barkley Rosser and Prof. Atwell R. Turquette. (Studies in Logic and the Foundations of Mathematics.) Pp. vii+124. (Amsterdam: North-Holland Publishing Co., 1952.) 12 fl.

THIS manual forms a most distinguished contribution to the literature and development of many-valued logic. As such, its appeal must be mainly to the specialists, and to those whose interests lie in the formal structure of mathematical thought. Consequently, most of the space available is devoted to the necessary extension of truth tables, axiomatization, and quantification for particular predicate calculi.

In the present context, however, the authors' aim—stated quite simply—is to see what happens when the possibility is admitted that a given situation may be other than true or false. This concept is introduced by a delightful dialogue in which the two authors split up and re-unite their names, one (Turquer) arguing for the *status quo*, and the other (Rossette) for adventure. The result, of course, is a foregone conclusion, as otherwise the book would never have been written. Adventure wins, and, heartened by the historic triumphs of non-Euclidean geometries, a start is made.

An intriguing section deals with some unanswered questions, and the probability of increased complexity when decision-problems have to be tackled in many-valued logics. The authors might well have mentioned the use which theoretical physicists are beginning to make—in fact, may be compelled to make—of many-valued systems in some of their crucial concepts. For all these reasons, this little book is likely to become a classic in its own right.
F. I. G. Rawlins

Dartmoor

By L. A. Harvey and D. St. Leger-Gordon. (The New Naturalist Series: a Survey of British Natural History.) Pp. xiv+273+40 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 25*s*. net.

THIS recent addition to the New Naturalist Series will appeal to many readers because of the intrinsic interest and appeal of the region described, and the very readable way in which the authors have presented their subject. In particular, scientific readers will appreciate the thoroughness of treatment and, not least, the cautious reserve that permeates the text. Dartmoor is described and discussed in the text in terms of its value as a national park, its physical pattern, geology and climate, its moors, tors, bogs and woodlands, its rivers and pools, its flora, fauna, prehistory, history and the customs and outlook of its contemporary denizens. Some valuable floristic and faunistic lists are given, and the volume is attractively illustrated throughout.

THE FLOW OF GLACIERS*

By Dr. M. F. PERUTZ
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Introduction

GLACIERS are fed by the snowfields which flank the high mountains. Snow deposited there is transformed into ice in the course of five to ten years. The ice flows down to the valley, where it gradually melts away until nothing is left but the rubble which the glacier carried down with it from the heights, piled up in an ungainly moraine.

In summer, a horizontal line can be seen dividing glaciers into two distinct regions: the upper one which is permanently covered with snow, because the summer's heat never suffices to melt away the snow deposited in the preceding winter, and the lower one in which the bare ice is exposed because melting and evaporation are dominant. In a glacier at equilibrium the amount of snow deposited is balanced by the water removed, and the size of the glacier remains unchanged. For the past fifty years the glaciers have lived on the reserves accumulated during the rich snowfalls of the Victorian era, and some have now shrunk to mere shadows of their former selves.

There are many kinds of glaciers. Some are scarcely more than snow patches and flow only a few feet a year. The valley glaciers of the Alps, of which the Mer de Glace is the best known, and the most visited, flow with velocities of one, two or three hundred feet a year. The gigantic ice streams of Greenland and Alaska which terminate in the sea flow much faster. The record is held by the Umanak Glacier in Greenland, which attains an annual velocity of several miles.

Ice is apparently rigid and brittle, yet glaciers flow like streams of a very viscous liquid. The streaming motion can be observed by watching the gradual distortion of certain pressure waves which form at the foot of ice-falls. When they first form, these waves skirt the ice-fall in a slightly curved line; as it flows down the glacier, each line is gradually drawn out into a parabolic curve pointing valleywards, which shows that the ice flows faster in the centre of the glacier than at the sides, like water in a river.

Theories of Flow

The flow of glaciers has always puzzled men of science, and until recently glaciological literature has been a battlefield of contradictory theories. The theories can best be explained by considering the fate of a rubber tube extending vertically from the surface to the bed of a glacier (Fig. 1). Somigliana regarded ice as a liquid of constant viscosity, which implied that its rate of flow would be directly proportional to the stress. The rubber tube would be deformed into a parabola, with the velocity of flow at the bed approaching zero. This theory clearly fails to explain glacial erosion. Orowan proposed the fruitful idea that ice behaves as an ideal plastic solid: substances of this type are assumed to be infinitely rigid until a certain limiting stress is reached; they then give way with infinite ease. If ice were ideally plastic, the depth of glaciers would have to be such that the limiting stress is reached at the bed, where all flow would be concentrated. Orowan's ideas formed the starting point for Nye's important theoretical advances to which I shall refer later in my lecture. Chamberlin and Philip fixed their attention on certain internal thrust planes which they believed to be of crucial importance, while Streiff-Becker and Demorest proposed a fast-flowing layer in the centre of the glacier, an idea which gained widespread adherence despite its mechanically improbable nature.

None of these theories could form the basis for any real advance in our knowledge so long as there existed no experiments either to confirm or disprove them. This state of affairs stimulated a group of people to try to discover the physical laws governing the flow of ice and the molecular mechanism on which these laws are based; to apply these laws to the flow of glaciers and to test them by direct measurement of the velocity distribution inside them. In Great Britain, the most active members of this group have been G. Seligman, president of the Glaciological Society, W. V. Lewis, E. Orowan, J. McCall, J. F. Nye, J. W. Glen and myself. Many others have made important contributions.

Deformation of Ice Crystals

The water molecules in an ice crystal are arranged in a succession of parallel layers, each layer consisting of a honeycomb of puckered hexagonal sheets. In a large ice crystal a misfit, usually called a dislocation, sometimes weakens the cohesion between two neighbouring layers, and when a stress is applied to the crystal the two layers glide over each other. Steinemann has found indications that such dislocations occur at intervals of 10–20 million layers.

Glen[1] made a rod-shaped ice crystal with the layers at 45° to the length of the rod and clamped it in an

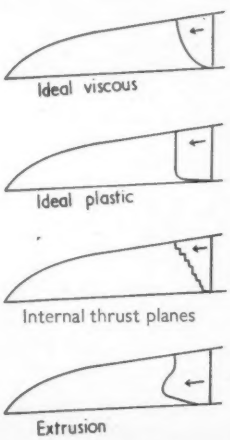

Fig. 1. Velocity distribution along a vertical line through a glacier according to different theories of flow

* Substance of a Friday Evening Discourse at the Royal Institution, delivered on June 5.

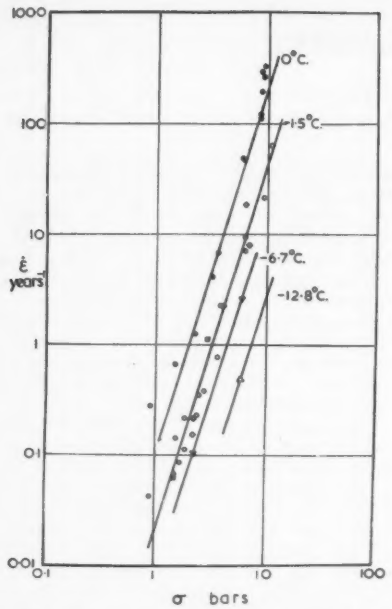

Fig. 2. Plot of logarithm of minimum rate of creep of ice against logarithm of stress. ●, points from creep tests very close to the melting point; ○, points from tests at − 1·5° C.; ◇, points from tests at − 1·5° C. after increasing the stress; □ points from tests at − 1·5° C. after decreasing the stress; ▼, points from tests at − 6·7° C.; △, point from test at − 12·8° C.

extension machine. When a small continuous pull was exerted on the rod it stretched to a thin tape of many times its original length. This shows that a single crystal of ice can be deformed plastically by continuous application of a small stress (of the order of a few kgm./cm.²), although it suffers brittle fracture when a large stress is suddenly applied.

The same is true of a multicrystalline block of ice in which the crystals are closely interlocked and oriented at random. If a small load is applied to a block of such ice, compression is found to go on rapidly at first and then more slowly until it settles down to a constant rate, known as the rate of quasi-viscous creep. Behaviour of this type is commonly observed in metals, and ice near its melting point merely differs from them by requiring very much smaller loads to produce the same rate of compression.

The important feature from the glaciological point of view is the dependence of the creep-rate on the load and on the temperature. These relationships have recently been discovered by Glen, whose elegant and painstaking experiments provide the key to our understanding of glacier flow[2]. At constant temperature and with loads of between 1 and 10 kgm./cm.² the creep-rate varies as the 3½rd power of the load. If the load is kept constant at 6 kgm./cm.² and the temperature varied, the creep-rate drops by a factor of five between 0° and −1° C. and by a factor of 10 between −1° and −10° C. (Fig. 2). From the temperature-dependence of the creep-rate, Glen was able to show that creep is essentially due to the thermal motion of the water molecules in the crystal which constantly try to change their places; an external load merely provides the extra push needed to give direction to this general movement.

These results have been obtained with small specimens of ice made in the laboratory. Would they necessarily hold if the scale were enlarged several thousand times and the block of ice assumed the dimensions of a glacier? This point has been tested in the following way. Any cavity hollowed out of a glacier contracts under the weight of the overlying ice layers. If a tunnel is dug into a glacier and its rate of contraction measured at different points along its length, the relation between creep-rate and load can be calculated.

Suitable tunnels have been dug in Norway by a Cambridge expedition under the leadership of McCall and Lewis, and in Switzerland by engineers of the West Swiss Electricity Company under the guidance of Haefeli[3,4]. The results of their measurements have been used by Nye to derive a relation between creep-rate and shear stress which is in reasonable agreement with Glen's laboratory tests[1,2].

$\dot{\gamma} = k\tau^n$: Laboratory $k = 0{\cdot}4$ At 0° C. $n = 4$ Tunnels $k = 0{\cdot}33$ $n = 3$

$\dot{\gamma}$ = shear strain per year; τ = shear stress in bars
k and n = empirical constants.

Application to Glaciers

In applying this law to glaciers, it must be realized that it can be used only to derive the amount of flow *within* the ice; it provides no information about the speed of sliding on the glacier bed. What can be calculated is the difference between the velocity at the surface u_0 and the velocity at any depth u_d[5]:

$$u_0 - u_d = \frac{k}{n+1} d\tau^n. \qquad (1)$$

If this relation is plotted for a glacier four times as wide as it is thick with a slope of 1 : 10 (Fig. 3), it is seen that no perceptible flow within the ice would occur at a depth of less than 100 m.; on the other hand, at a depth of 1,000 m. the annual velocity would exceed 30 km., which is more than anything known to-day.

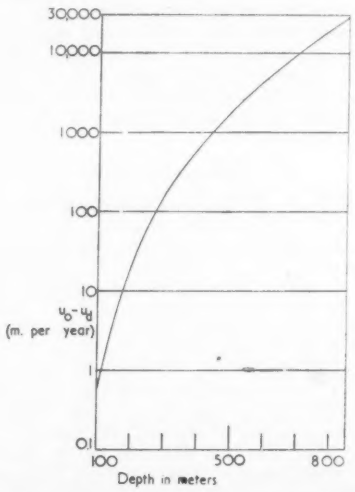

Fig. 3. Difference between the surface velocity u_0 and the velocity u_d at a depth d calculated from Glen's flow law. The glacier is assumed to have a slope of 1 : 10 and to be four times as wide as it is deep

A glacier tongue has to remove an amount of ice equivalent to the annual net accumulation of snow which the entire glacier receives. If we take the accumulation area of a typical Alpine glacier as 10 km.², and the net accumulation as 50 cm. of ice per year, then the volume of ice to be removed by the glacier tongue in one year is 5×10^6 m.³. On the basis of the graph the volumes removed by glacier tongues of different depth are:

d	V
100 m.	10,000 m.³
250	6×10^6 m.³
1,000	10^{11} m.³

Thus to remove the right volume of ice, glacier tongues of slope 1 : 10 would have to be between 200 and 300 m. thick. Of known glaciers of this slope, the Grenz Gletscher is 290 m. and the Rhone Glacier 200 m. thick, which shows that the values predicted by the flow law are about right.

Another way of testing the equations of flow is to see if they predict reasonable surface velocities for glaciers of known depth. For this purpose u_0/d has been plotted against the shear stress for various glaciers (Fig. 4). The observed velocities are on the average about twice those predicted by Glen, the difference being presumably accounted for by sliding of the glaciers over their beds; but clearly the agreement is as good as can be expected. A further interesting feature of this graph is the small variation in the shear stresses at the bed of different glaciers, which all lie between about 0·5 and 1·5 kgm./cm.². This shows that the shear stress at the bed needed to produce a velocity of flow sufficient to balance the precipitation at the head of a glacier is generally of the order of 1 kgm./cm.², at least in Alpine glaciers which are at the melting point throughout most of their mass.

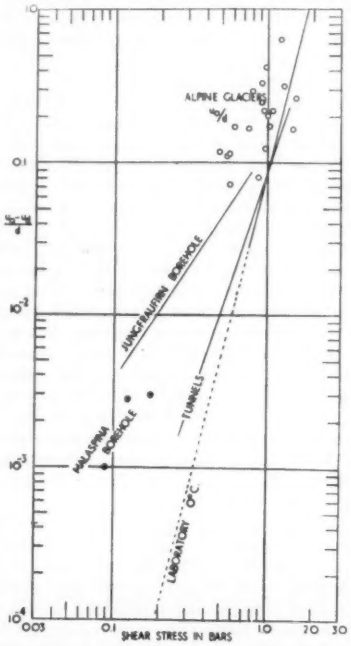

Fig. 4. Comparison of the observed surface velocity of Alpine glaciers, and the velocity distribution measured inside glaciers, with the corresponding quantities predicted from Glen's flow law, using equation (1). The broken part of the 'Laboratory' line is extrapolated

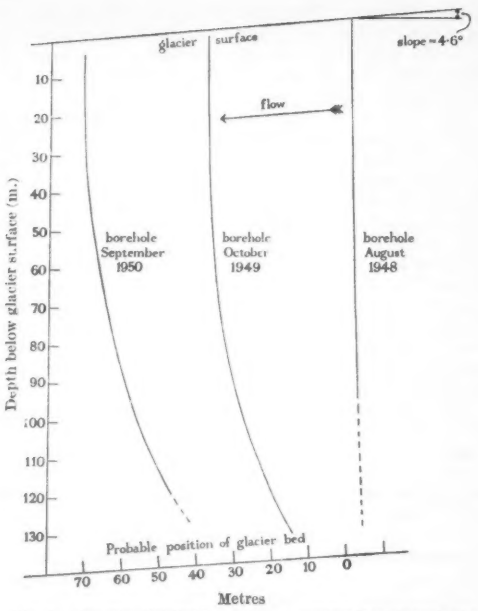

Fig. 5. Velocity distributions along a vertical line through the Jungfraufirn. The lines show the position of the borehole in three successive years (Gerrard, Perutz and Roch, *Proc. Roy. Soc.*, A, **213**, 553 (1952))

Direct Measurement of Vertical Velocity Distribution

The most certain method of testing the equations of flow, together with the many theories of flow previously proposed, is the direct measurement of the velocity distribution along a vertical line through a glacier. The first experiment of this kind was done by Gerrard, Roch and myself[6], using a method which had been suggested to us by Sir Edward Bullard. A vertical hole is drilled into a glacier and lined with a flexible steel tube. This tube is left in the glacier, to be tilted and bent by the flowing glacier according to the different velocities prevailing at different depths. If the angle of tilt of the tube is measured all along its length at the start of the experiment and again after suitable intervals of time, the difference between the surface velocity and the velocity at any depth can be calculated.

This experiment was done on the Jungfraufirn, a few hundred yards below the Jungfraujoch Research Station. A hole 400 ft. deep reaching from the surface to the bed was made with an electric heating element and lined with a 3-in. steel tube. The inclination of the tube was measured with an electrically recording pendulum instrument designed by Jason and Broad.

The results of the pipe experiment can be summarized in one illustration which shows the position of the tube in three successive years (Fig. 5).

Of the surface velocity of 35 m. per year, roughly one-half is accounted for by sliding over the bed and the other by flow within the ice. The rate of flow decreases regularly from the surface downwards, and there is no sign of a fast-flowing layer in the interior

of the glacier. The rate of shear within the ice increases too fast with depth for ice to be a liquid of constant viscosity and approximates to a relation where the rate of strain is proportional to the 3/2 power of the shear stress.

Our method of measuring the velocity distribution in glaciers has been taken up by two groups in the United States: one under Mr. M. M. Miller, working in the Juneau Ice Field, and the other under Prof. Robert Sharp[7], working on the Malaspina Glacier, both in Alaska. Sharp's first results with a thousand-foot borehole have recently been published. The inclination of the glacier at the site of the borehole is only 22°, so that the deformation of the borehole is slow. It will take several years to get definite results; but in the meantime the preliminary measurements can be compared with those obtained on the Jungfraufirn and with the velocity distribution predicted from Glen's flow law.

The quantity which is most conveniently compared is the flow within the ice, $u_0 - u_d$, divided by the depth d (Fig. 4). At shear stresses of the order of 1 bar, the agreement between theory and experiment is good, but at lower stresses the glacier ice is deformed much faster than Glen's flow law would lead us to expect. This may be due to some extent to the high air-content of the ice on the Jungfraujoch and the high water-content of the ice in the Malaspina glacier; but the most important part of the discrepancy is probably due to a phenomenon which is of the utmost importance in glacier flow and which had never been clearly understood until it was pointed out in a brilliant theoretical paper by Nye[8].

Longitudinal Compression and Extension

The shear stresses shown in Fig. 4 have been calculated on the assumption that the glaciers descend by simple shear on an evenly inclined plane. In reality, glacier beds consist of a succession of hollow basins alternating with steep steps. When a glacier descends over a step, its speed rises and its depth is reduced, and when the bed flattens the converse process occurs, just as a stream tends to be shallow when it descends over rapids and deep as it flows through a plain. Nye[8] showed that the thinning and thickening of the glacier introduces additional strains which cause the velocity distribution to be distorted from a straight line—the solution for an ideally plastic glacier descending on an evenly inclined bed—to an ellipse. This process would produce just the kind of departure from Glen's flow law which is actually observed.

The importance of Nye's theory lies in the fact that it suggests an explanation for the peculiar erosive power of glaciers, namely, the hollowing-out of corries and basins which are so characteristic a feature of the once glaciated landscape. Nye suggests that the banking-up which occurs when a glacier is compressed might actually lead to failure along a series of planes where the stress is greatest. These planes intersect the surface at 45° and approach the bed asymptotically. Nye suggests that these thrust planes might pick up debris from the glacier bed and carry them up towards the surface, rather like gravel being picked up from the ground when snow is pushed from the doorstep. When the glacier is stretched by descending over a convex slope, the converse set of thrust planes would be formed. I should like to emphasize that although thickening and thinning, that is, the banking up and stretching of glaciers, are essential features of their flow, these might equally well take place by uniform compression and extension of the ice.

The thrust planes are an attractive feature because they explain erosion; but they are not an essential feature with a flow law of the type proposed by Glen. Flow along a thrust plane inclined at 45° to the glacier surface was found by Seligman and myself[9] in a grotto in the Eigergletscher, where it went hand in hand with uniform deformation of the ice underneath; but this thrust plane contained no rock debris. It will be interesting to see whether a thrust plane containing such debris can be discovered, and confirmed by direct measurement of the rate of overthrusting.

Rotational Slip

There is one particularly simple way in which a hollow basin might be ground out by a glacier. If Nye's two types of thrust planes come sufficiently close together, the entire glacier could rotate about a horizontal axis, a type of motion first envisaged by Ward and Lewis.

It was in an attempt to test this idea that McCall assembled a large party of Cambridge undergraduates and inveigled them into digging two tunnels from the surface to the bed of the small Skauthoe Glacier in Norway. By surveying the movement of different points along the glacier surface and along the length of the tunnels, McCall[3] showed that the entire glacier flows by rotation around a horizontal axis. The thickness of this glacier nowhere exceeds 60 m., which is too little for appreciable flow within the ice to occur. Most of the flow, in fact, seems to be concentrated in a thin layer of sandy ice near the bed, which appears to be hollowed out largely by friction, and thrust planes within the ice are absent.

McCall's strenuous experiment has broken new ground by giving us a glimpse of glacial erosion in action, together with a quantitative picture of every detail of a glacier's movement.

Summing up, we may say that the flow law of ice found in the laboratory provides a new basis for research on the flow of glaciers. Its general validity in glaciers has been verified by measurement of the rate of contraction of tunnels and by comparison of the surface velocities and depths of Alpine glaciers with the values predicted from the flow law. The vertical velocity distributions in glaciers agree with the flow law at shear stresses of the order of 1 bar, but depart from it at smaller stresses. The departure may be explained by the longitudinal compression and extension which glaciers undergo in response to changes in the shape of their bed. Longitudinal compression may also give rise to slip along thrust planes in the course of which debris might be picked up from the bed and shifted towards the surface. This is suggested by Nye as a possible mechanism of glacial erosion[10]. Erosion of a corrie by rotational slip of an entire glacier has been demonstrated in Norway.

[1] Glen, J. W., *J. Glaciol.*, **2**, 111 (1952).
[2] Glen, J. W., *Nature*, **172**, 721 (1953).
[3] McCall, J. G., *J. Glaciol.*, **2**, 122 (1952).
[4] Haefeli, R., *J. Glaciol.*, **1**, 496 (1951); **2**, 94 (1952). Haefeli, R., and Kasser, P., Assoc. Int. d'Hydrologie Scientifique Assemblée Générale de Bruxelles, **1**, Part 3, 222 (1951).
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[9] Perutz, M. F., and Seligman, G., *Proc. Roy. Soc.*, A, **172**, 335 (1939).
[10] Nye, J. F., *Proc. Roy. Soc.*, A, **219**, 477 (1953).

NORTH ATLANTIC WEATHER SHIPS

PRESS reports show that the United States Government has notified the International Civil Aviation Organization of its intention to withdraw the weather ships which it maintains in the North Atlantic when the present international ocean weather ship agreement expires on June 30, 1954.

Ocean weather ships occupy 'fixed' ocean stations and perform several duties. These duties include the making of surface and upper-air meteorological observations at frequent definite intervals and transmitting the data by radio for use in weather forecasting; navigational aid to aircraft in flight by giving radio bearings and radar fixes, transmitting the latest surface and upper-air observations to aircraft on request and acting generally as relay stations between aircraft and air-traffic control centres; air-sea rescue duties; and making oceanographic and other scientific observations as opportunity permits. The ships are located at positions carefully selected for best fulfilment of their meteorological and navigational aid duties from the Norwegian Sea to between the Azores and the United States.

The North Atlantic weather station scheme was arranged at a conference of the International Civil Aviation Organization in 1946 and modified in 1949 by reducing the number of stations from thirteen to ten. The total cost is shared among the participating nations in proportion to the number of flights made across the Atlantic by their civil aircraft.

At present, the United States wholly maintains four stations, the United Kingdom one and Norway with Sweden one. The Netherlands assist in the operation of one station with the United States, one with Great Britain, and one with France; Canada assists the United States in operating one; and certain other nations contribute financially to the scheme. The number of ships needed to man the stations is at least two per station and may be three according to distance from base. The United States employ coastguard cutters, Great Britain and Norway "Flower" class corvettes, and the other participating countries use frigates in the weather ship service.

Besides those in the North Atlantic, the United States, Canada, and Japan maintain weather ships in the North Pacific under an entirely separate arrangement.

The cessation of reports from the American weather ships would handicap weather forecasters working for the North Atlantic air routes mainly by the loss of upper-air information. Location of the often rather narrow belts of high wind, the so-called jet-streams, which may seriously increase the flight-times of aircraft flying against them, is a matter of much concern to the North Atlantic forecaster. Pre-flight planning of the fuel to be carried by trans-Atlantic aircraft is based on the forecast upper winds. To obtain the same degree of safety with less certain knowledge of the winds to be expected would necessarily mean on many occasions that airlines would have to sacrifice paying load to carry more fuel as an insurance against the increased risk of encountering headwinds stronger than forecast. This would be a direct financial loss to the airlines of all countries concerned in North Atlantic flying.

Valuable observations are regularly made and transmitted by voluntary observers on merchant ships, but not so frequently as by the meteorologists on weather ships, and, in particular, they include no upper-air observations. Merchant ships are, of course, almost always moving, and even with the good organization in force for collecting their reports, large areas without observations on the weather maps are inevitable.

Apart from the immediate use of weather ship observations in forecasting, the detailed logs are interchanged among the nations for the building up of a comprehensive climatology of the North Atlantic from the surface to heights of more than 50,000 ft. Never before have continuous weather records from fixed ships in mid-ocean been obtained. Further, the ships provide admirable laboratories for special investigations in oceanography and other geophysical subjects, and small expeditions from university research institutes have worked in them.

It is to be hoped that a new agreement providing for the maintenance of some, at least, of the American stations will be reached before the present one expires.

A WHALE-MARKING EXPEDITION

By DR. N. A. MACKINTOSH, C.B.E.
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THE marking of whales can assist nearly all investigations on the populations and life-cycle of whales, it seems the only satisfactory method of gaining information on many aspects of their distribution and movements, and it was carried out on a considerable scale by the Discovery Committee before the Second World War. A previous article in *Nature*[1] gave a summary of the information already obtained from recovered marks, and directed attention to the need for more marking, both in the Antarctic and in other regions. It was noted that the National Institute of Oceanography (which now includes the Discovery Investigations) could not now meet the cost of special marking expeditions; but the hope was expressed that some means of continuing the work would be found.

The generosity of a number of whaling companies has now led to such an expedition, and a ship is on the way to the Antarctic to mark whales during some weeks immediately before the opening date (January 2) of the whaling season of 1954. The marking has been organized jointly by the National Institute of Oceanography and the Norwegian State Institute for Whale Research.

The importance of whale marking had been endorsed at recent meetings of the International Whaling Commission, and after correspondence with the National Institute the former chairman of the Commission (Ambassador B. Bergersen) and the secretary of the Association of Whaling Companies (Mr. E. Vangstein) took the initiative in approaching the whaling companies. In the summer of 1953 a number of these companies (British, Norwegian, Dutch and South African) agreed to share the cost of about a month's marking by the modern whale catcher *Enern*, owned by the Norwegian company, A/S Thor Dahl. Whale catchers hitherto had not been the ideal ships for whale marking on account of their relatively short cruising range, which tended to restrict marking to the immediate field of hunting. But the *Enern* is a powerful new diesel-driven vessel with a cruising-range which enables her to sail more than a month in advance of the parent factory ship, from which catchers are normally refuelled.

The *Enern* is expected to reach the edge of the pack-ice in the later part of November, and to mark whales between the Greenwich meridian and South Georgia in the Dependencies of the Falkland Islands. Prof. J. T. Ruud, director of the State Institute for Whale Research, is in charge of the work, and sailing with him are Mr. R. H. Clarke, of the National Institute of Oceanography, Mr. Per Øynes, also of the State Institute, and Mr. van Utrecht, of the Netherlands Whales Research Group. December is a little early for finding the maximum number of whales, but on the other hand the work will be done by a much more powerful vessel than has yet been used for whale marking, and she is commanded by an experienced whaler, Captain M. Marthinsen. Much depends, however, on the weather.

Very little marking has been done in the Antarctic since the War, and of the pre-war marks only small numbers are now being recovered each year. The main object of the present cruise is simply to increase the number of marked whales at large, and hence the number of marks recovered; but it is also intended to test the value of certain modifications to the standard 'Discovery' mark, which have been devised by Prof. Ruud and his colleagues to improve their effectiveness, and to estimate the chances of marks being overlooked when the carcasses are treated at the factories. In July this year some experiments were made by Prof. Ruud, Mr. Clarke, and Mr. A. Jonsgård at a whaling station at Steinshamn in Norway. Preliminary tests with the modified marks showed that they were worth extensive trials on a whale-marking voyage, and examination of the carcasses of marked whales and the position in which a mark is lodged after penetrating the blubber gave further evidence that there is little risk of injury to the whale. An account of these experiments has already been published[2]. It is hoped that with improved efficiency in the recovery of marks, the ratio of marks recovered to marks fired will come nearer to the ratio of total whales killed to total whales in the population. The latter ratio is at present unknown, and it is naturally of great importance. Large numbers of recovered marks are needed, not only to make the ratio of recovered marks more significant but also for studies of migration, of the rate of dispersal or interchange between the populations of different regions, and of the age and rate of growth of whales. Of course, a single new marking voyage will not dispose of all these problems, but it is hoped that it will lead at least to some progress in the investigation of this interesting mammalian population and assist the work of the International Whaling Commission.

For subsidiary work during the voyage, especially for observations on sea temperatures and the shoals of krill (*Euphausia superba*) on which whales and other animals feed, the *Enern* is equipped with a sea-thermograph, a 'fish-finder' echo sounder, a bathythermograph, and a 1-metre townet.

It has been arranged that the National Institute of Oceanography will act as co-ordinating body, and will receive all recovered marks. The Norwegian Institute will receive duplicates of all such data, and the two organizations will co-operate in examining the material. A report on the voyage will be sent to the International Whaling Commission and to the whaling companies participating in the scheme.

[1] Mackintosh, N. A., *Nature*, **169**, 435 (1952).
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PHYSIOLOGY OF ATHLETIC TRAINING

ALTHOUGH a large amount of time, effort and money is expended on the training of human and animal athletes whose subsequent performances are witnessed in the aggregate by thousands of spectators, it was probably the inherent interest in the subject which led the Physiology Section (I) of the British Association to devote a whole day at the Liverpool meeting to a symposium on the "Physiology of Athletic Training". The methods of training both men and animals are mainly empirical; but by having a panel of speakers made up of physiologists, active athletes, trainers and coaches of both animals and men, it was hoped that the papers and subsequent discussion would show what assessment, on a physiological basis, could be made of training methods.

Middle- and long-distance running was taken by Prof. A. Hemingway (University of Leeds) as a fairly straightforward example of athletic performance. It requires skill, but not in the sense of using specialized techniques of handling implements or of employing strategy and tactics as in complex games. The limitations to performance in running are ultimately dependent on chemical reactions in muscle. Some of the reactions are anaerobic; but they can only be used to a limited extent. If oxygen is available the overall reactions can be aerobic, and the extent to which they are used is dependent upon the oxygen supplies to the muscles. If the rate of energy liberation outstrips the available oxygen supplies, then part of the energy must be supplied by the anaerobic mechanisms. But as these are limited, fatigue must ultimately ensue, the period elapsing before its onset depending on the rate of energy liberation. The fundamental problems of the athlete are to convert his energy into locomotion with maximum efficiency and to provide as large a proportion of the energy as possible by aerobic mechanisms. To what extent does training help in solving these problems?

Comparisons between trained and untrained men show great differences in their ability to take up oxygen. The highest rate of oxygen uptake measured on a trained athlete is 5·3 l./min. when breathing atmospheric air at normal pressure. The ability to transport oxygen at this rate from the lungs to the working muscles seems to depend upon a large output of blood from the heart. Such differences as there are between the capacity of the lungs, the rate at which they can be ventilated, or the composition of the blood, in trained and untrained men are insufficient to explain the discrepancy between their ability to take up oxygen. The main difference seems to be in the output of the heart. Recent advances in the technique of measuring the output of the heart make it possible to estimate that the maximum output may rise to about 40–50 l./min. in a first-class middle-distance runner. The severe training methods used by some long-distance runners increases the strength of both the skeletal muscles and the heart. The athlete makes optimum use of the oxygen which is available through this large blood output by running usually at a constant pace and by employing an economical style. Recent Scandinavian work illustrating the relationship between stride-length and efficiency of running was

quoted by Prof. Hemingway. For a given pace there is an optimum length of stride. Preliminary exercise —'limbering-up'—improves subsequent performance and seems to produce its effects through a local increase in temperature of the working muscles. Whether the change in temperature directly affects the properties of the muscle or operates by producing an increase in blood flow is still undecided.

That lack of oxygen is the main factor limiting the distance runner was stressed by Mr. Roger Bannister (St. Mary's Hospital Medical School, London), who described experiments which he had performed in Oxford upon himself and athletic colleagues. The subjects undertook severe standardized exercise on a treadmill, while breathing mixtures of oxygen and air. They were exhausted after running for about eight minutes with atmospheric air; if oxygen was added to give 33 per cent concentration, the performance was improved, while with 66 per cent oxygen the runners appeared to be able to continue indefinitely. It was suggested that because of vascular shunts in the lungs, there might be an actual reduction of the oxygen saturation of the arterial blood during severe exercise which was mitigated by enriching the air with oxygen. If so, training might be regarded as an alternative to the use of an oxygen mask!

Training methods in current use were described by Mr. G. H. G. Dyson (chief coach, Amateur Athletic Association). With the aid of 'loop films', which enabled the audience to have a particular phase of movement projected repetitively, he showed the characteristic styles of champion long-distance runners, emphasizing how the stride is developed from a vigorous thrust, or drive, of the back leg. The back leg, often flexed at the knee with the foot above the level of the knee joint, is then swung forward in pendular fashion, and the runner lands almost flat-footed with the foot very little in front of the body. The length of stride is rather shorter than might be expected from body height. Training aims at developing strength, endurance, efficiency of movement and judgment of pace. Although the methods of various successful athletes may appear to differ, they are very similar in their essentials. Early training for the development of muscular strength might consist, as with the Scandinavians, in running in snow, or cross-country running, or even running in heavy boots. This would be followed by later training in which the athlete would obtain practice in running at a speed appropriate to his race, interspersing his faster running between longer periods of slower running. Thus, in training on a track, an athlete aiming at a record performance at three or six miles (5,000 or 10,000 metres) might run one lap (¼ mile) at racing speed and follow it by three or four laps at a slower speed. This training might be continued for two or three hours, while the athlete runs about twenty miles.

To some extent the athlete, already possessing ability, improves in strength, endurance and skill by repetition in training of a standard performance at intervals long enough to avoid fatigue. But attempts have been made to strengthen specific muscle groups by special training, and Mr. G. T. Adamson (University of Leeds) touched on this subject when he described experiments on undergraduates in which the limit of each individual's capacity to perform certain movements—for example, the number of times a beam could be 'chinned'—has been determined. The subject then makes a circuit, which contains a number of these tests, in a given time and performs each one a certain proportion—say a half or a third—of his maximum. Periodic testing showed significant improvement in performance, both for strength and endurance, and the training rate was altered accordingly. This method of training differs from that usually followed by an athlete because the amount of work prescribed for training is quantitatively adjusted to the previously assessed capacity of the subject.

Two papers on animal training emphasized a theme already raised by Mr. Bannister in discussing the physical build of athletes: runners are bred rather than made. The training of the track-racing greyhound was described by Mr. J. K. Bateman (Greyhound Racing Association) in a paper read by Prof. E. C. Amoroso. Great attention is paid to the diet of the puppy to ensure proper skeletal and muscular growth, and from about three months old he is given plenty of opportunity for free exercise. Even a short period off his legs during the phase of rapid growth is likely to prevent a puppy from becoming a satisfactory racing dog. When about a year old, running training begins, and the galloping distance is gradually increased until the puppy can run at full speed for about 250 yards. Regular work and good feeding are continued on a progressive scale, but the distance over which the dog runs at full speed is only gradually increased, and he will only do this occasionally. Even when the dog is fully trained and in racing trim for races of 500–700 yards, a full-speed run over a distance is only done two or three times a week.

Each day when in racing trim the dog, apart from a period of about fifteen minutes self-exercise, has a walk of about two miles at a slow trotting pace. It was interesting to hear how much less training work is undertaken by canine sprinters as compared with the corresponding human athlete. When endurance is required, as in the coursing greyhound, a great deal more road walking is undertaken. The dog does not control his speed. He will always go all out at the beginning of a race, and his speed diminishes as he tires, unless some slight break, as in coursing or hunting, gives opportunity for recovery. A horse can undertake long-distance races because he is controlled by the jockey, and his energy output can be spread over a period.

The importance of breeding in the production of the successful racehorse was stressed in a paper by Mr. J. L. Jarvis, the Newmarket trainer, read by Mr. W. C. Miller (Equine Research Station, Newmarket). Almost all the winners of classic races can be traced back in their pedigree to some great race mare. Mr. Jarvis outlined the sequence of training a horse for the Derby, where a combination of speed and endurance is required. Training begins with the breaking in of the horse as a yearling, and he is regularly exercised for about an hour and a half each day during his first season. The next year, in the spring, he will first be given some trotting exercise on the roads, and then steady cantering exercise which is gradually increased in pace and distance. The prime aim of this training is said to be the building up of the muscles; but at the same time the resources of the circulation are increased so that the animal is able to meet the increased capabilities of the muscle with better supplies of oxygen. Training occupies about an hour and a half each day, unless the horse is being trained for

distance races, when it will be longer. Unlike the human athlete, running over even shortish distances at a likely racing pace does not seem to be part of the technique of horse-training. The way in which a race is actually run—the initial pace, the running for position—depends upon the jockey and not upon the horse's judgment of pace. Training is an art, declared Mr. Jarvis, and a training routine must be suited to the mental and physical constitution of each particular animal.

Finally, Mr. J. Lynas (Blackpool Football Club) and Mr. J. Egan (Leigh Football Club), two well-known trainers and coaches of professional footballers, Association and Rugby League respectively, gave accounts of their methods of training. They made it clear that a general fitness for endurance and ability to run quickly on occasion makes only a foundation on which the particular skills of the game can be imposed. Mr. Egan analysed the duties of the different players in a team, showing, for example, how the physical and physiological requirements of a wing three-quarter in Rugby football differ from those of a forward and pointing out that, although an all-out run of fifty yards is usually a maximum, very few players are likely to undertake it; frequently, very rapid acceleration over a few yards is more important than first-class sprinting ability. Initial training at the beginning of the season concentrates on distance running to promote endurance, and more specific practice in sprinting, kicking and ball-handling is taken according to individual requirements. While Mr. Lynas seemed less inclined to regard an Association football team as a collection of specialists, his training requirements seemed to be on similar lines, with emphasis on the practice of the skills required for the game. Both trainers regarded speed in running as unimportant in itself. Many great players have been relatively slow runners, but their knowledge of the game and anticipation has often given them actually several yards start of their opponents.

One point which emerged clearly from the papers and from the discussion was that the term 'fitness' should be applied only towards a specific end. A certain degree of muscular development and ability, through the circulation, to transport oxygen is necessary for any sustained muscular activity—this might be termed a 'general fitness'. But beyond this there must be a 'specific fitness' involving the development of particular muscles and the acquirement and use of particular skills, such as pace judgment and economy of effort for the athlete, game technique for the football player and control of the horse by the jockey.

OBITUARIES

Dr. Winifred Brenchley, O.B.E.

DR. WINIFRED BRENCHLEY, the well-known agricultural botanist of the Rothamsted Experimental Station, died at her home at Harpenden, on October 27, after a long and crippling illness which, however, was mercifully without great pain for her. She was born on August 10, 1883; her father was a popular and successful schoolmaster at Camberwell, serving at one time as mayor of the Borough. In early childhood, while recovering from measles, a well-intentioned friend took her out for a drive: she caught a chill which so gravely injured her ears that she suffered all her life from deafness. But she never allowed this to interfere with her work or her social activities or with her never-failing helpfulness to her younger colleagues.

From James Allen's School, Dulwich, she went first to the Swanley Horticultural College, and then to University College, London, to study under F. W. Oliver, with whom there grew up a life-long friendship. In 1906 she went to Rothamsted, the first of the staff that A. D. Hall was then assembling, and the first woman scientist to be appointed, either there or at any other agricultural institution in the country.

She soon started investigations on plants by the water culture method which she, and afterwards her colleague Katherine Warington, developed into an instrument of remarkable effectiveness. From the outset she included metallic salts known to be toxic at high concentrations, and watched for the stimulus they were supposed to exert at low concentrations: spectrographic methods had not yet arrived, and she narrowly missed discovering the essential role of the trace elements. The earlier results are summarized in "Inorganic Plant Poisons and Stimulants", published in 1914 by the Cambridge University Press; a later revised and enlarged edition came out in 1927. The work continued, however, during all her time at Rothamsted: the last element dealt with was molybdenum.

Through Oliver's influence, Dr. Brenchley began a second group of investigations: ecological studies of the complex floras of farmed land. The effects of fertilizers in altering the competition-equilibrium between the various species in a meadow were described first in "The Manuring of Grassland for Hay" (Longmans) in 1924: but she was still continuing the work when she retired. Her studies of weeds in arable crops and grassland were brought together in "The Weeds of Farmland" (Longmans, 1920), extended later to include studies of the viability of weed seeds in the soil: she was able to show that some had remarkable powers of survival for many years. She also studied the effects on the growing plant of individual factors that make up the natural environment, especially temperature, light and nutrients. These botanical studies did not exhaust her scientific interests; she and Dr. A. D. Imms, then the Rothamsted entomologist, became great friends, and with his help she acquired considerable knowledge of insects.

Dr. Brenchley summarized the first thirty years of her work in the Rothamsted Annual Report for 1935, and the next ten years in the issue for 1939–45. She retired in September 1948, intending to write up her accumulated observations. These had been made with great care and deserved closer study than her busy working life had allowed; but her illness intervened, and it steadily grew worse to the deep regret of a wide circle of friends at Rothamsted and far beyond. E. JOHN RUSSELL

Dr. Wendell C. Bennett

WENDELL C. BENNETT, a distinguished student of Peruvian archæology, died on September 6 in his forty-eighth year. His end, while swimming off the shore of Martha's Vineyard in Massachusetts, was a tragic one.

At the time of his death, Bennett occupied a number of important posts at Yale University, where

he was a professor of anthropology, a fellow of Pierson College, a research associate of the Peabody Museum and chairman of the Department of Anthropology. These were a few of the academic evidences of a highly successful career, which had been remarkably steady in its progress and exceptionally fruitful both in scholarship and in personal influence.

Almost from the first, Bennett had devoted himself to the pre-history of South America. With the exception of two early apprentice essays, one on the culture of the Tarahumara of northern Mexico and the other on the archæology of the Hawaiian Islands, his research was directed almost exclusively to South American archæology. His first undertakings in this area were begun while on the staff of the American Museum of Natural History, where he remained for seven years. These were rewarding years, during which he laid the groundwork of his own subsequent researches which very largely were responsible in establishing Peruvian archæology on the sound footing it now occupies.

It was during this period that he made the first stratigraphic excavations in Bolivia, working at the famous site of Tiahuanaco. For this fundamental work he was decorated afterwards by the Bolivian Government. While still at the American Museum of Natural History he carried out significant excavations in the north coastal area of Peru and in Venezuela. The former led to a re-definition of the chronological sequences of Peruvian archæology and the latter provided the first systematic archæological data for Venezuela.

On leaving the American Museum of Natural History in 1938, he moved to the University of Wisconsin, attracted there by the opportunity to teach. In 1940 he was invited to Yale, where he remained until his death. During his association with Yale, Bennett was able, despite his teaching and administrative duties, to continue his archæological research. One of his outstanding achievements in this period of his career was the part he played in organizing the Virú Valley project. Out of this large co-operative venture came his fine study of the Gallinazo culture. The last archæological enterprise on which Bennett was engaged is not yet published, but it is in the press and is concerned with the problem of the development of coastal Tiahuanaco culture.

The confidence of his fellow anthropologists that Bennett enjoyed and his reputation for sound counsel were reflected in the numerous posts to which he was elected and appointed in professional societies and organizations. He was president of the American Anthropological Association in 1952, and executive secretary of the Joint Committee on Latin American Studies from 1942 to 1944. He was chairman of Yale's Area Studies Executive Committee, and he was active in the Social Science Research Council.

Wendell Bennett was born in the Middle West—in Marion, Indiana—on August 17, 1905, the son of William Rainey Bennett, a minister and lecturer. His schooling was in Chicago and his university career at the University of Chicago, where he was an excellent scholar as well as an exceptional athlete. In 1925 he married Hope Ranslow and from this marriage two daughters, Lucy and Martha, were born. As a person Bennett possessed great charm and warmth. He had a fine gift for friendship to which all varieties of people responded. It was, in fact, this lovable quality which contributed so greatly to his success in organizing. As an archæologist he was rigorous and critical, demanding the highest standards of professional competence from himself and from his colleagues. His contributions have been fundamental in advancing our knowledge of South American prehistory.

He will be mourned by a wide circle of friends and colleagues for the feeling of personal loss that the departure of a generous spirit always leaves, and for the sense of loss that the interruption of a full career always implies.

HARRY L. SHAPIRO

Prof. N. D. Zelinskii

NICHOLAS DIMITRIVICH ZELINSKII was born on February 6, 1861, in Tiraspol in the Province of Kherson. He received his school training locally and in Odessa, and afterwards went to the University of Novorossisk. Later he studied in Leipzig and in Göttingen, working there in the laboratory of Victor Meyer. In 1888 he obtained his master's degree and was appointed lecturer at his old University of Novorossisk. There he presented first his master's thesis dealing with thiophene chemistry in 1889, and two years later a thesis for his doctorate on the stereoisomers of saturated carbon compounds.

Zelinskii was appointed adjunct professor in Moscow in 1893 and, except for six years spent at St. Petersburg, remained there until his death on July 31 of this year. The six years interruption occurred during 1911–17, when in company with a hundred other professors and teachers he resigned as a protest against the dismissal of the entire administration staff of the University of Moscow by the Ministry of Education.

Although Zelinskii's contributions to chemical knowledge ranged over a vast field, including heterocyclic derivatives, protein hydrolysis and the synthesis of α-amino-acids, his chief contributions were to hydrocarbon chemistry. In 1891 he prepared the first synthetic naphthene, 1.3-dimethyl*cyclo*hexane, and showed its close relationship with the octanaphthene of Caucasian petroleum. This, and later work on the synthesis of saturated cyclic hydrocarbons, ranging from simple to complex polycyclic systems, brought with it an interest in petroleum and the terpenes. As early as the 'nineties he took an active part in the operation of a plant to prepare aromatic hydrocarbons by pyrolysis of petroleum, and thus was among the earliest pioneers of petrochemicals. Later, he showed that aromatics could be more conveniently produced from petroleum by catalytic dehydrogenation of naphthenes than by pyrolysis. This resulted from his discovery in 1911 that *cyclo*hexane derivatives can be converted to aromatic hydrocarbons by passage over a suitable catalyst, an observation which led to the establishment of a school of contact catalysis under his leadership. His contributions in this field were immense; he was the first to use platinum metals as hydrogenation/dehydrogenation catalysts and to differentiate between C_5- and C_6-naphthenes by their behaviour on dehydrogenation—a valuable tool in his investigation of the composition of petroleum. Isomerization, desulphurization, cyclization and many other processes of technical interest owe much to his pioneer efforts. His interests included also the origin of petroleum, where no doubt his early association, in 1889, with an expedition to the Black Sea, which proved the bacterial origin of the hydrogen

sulphides present in its depths, encouraged his views as to the organic origin of petroleum, views which he supported with experimental work on the thermal decomposition of sapropelite, a substance of algal origin deposited in vast quantities on the shores of Lake Balkhash.

Zelinskii's first paper appeared in the *Journal of the Russian Chemical Society* when he was a student in 1884, and in the sixty-seven years that followed he published more than five hundred others, including many with some hundred and forty of his students. On three occasions he was awarded the highest honour of the U.S.S.R.—the Order of Lenin. He also received numerous other honours from the government of the U.S.S.R., including the title of Hero of Socialist Labour.

S. F. Birch

We regret to announce the following deaths:

Dr. W. R. Cunningham, librarian of the University of Glasgow and keeper of the Hunterian books and manuscripts, on October 25, aged sixty-three.

Prof. Colin G. Fink, recently head of the Division of Electrochemistry, Columbia University, and president in 1917 of the Electrochemical Society in the United States, aged seventy-two.

Mr. H. J. Hornby, chairman of A. Gallenkamp and Co., Ltd., and chairman during 1941–43 of the British Laboratory Ware Association, Ltd., on November 2, aged sixty-eight.

Prof. E. Piwowarsky, professor of general metallurgy and director of the Institute for General Metallurgy and Foundry-work in the Technical High School, Aachen, aged sixty-one.

NEWS and VIEWS

Nobel Prize for Physics for 1953: Prof. F. Zernike

The work of Prof. F. Zernike, who has been awarded the Nobel Prize for Physics for 1953, includes many distinguished contributions in fields other than optics, but his successes in this branch of physics alone have been sufficient to earn him an international reputation. His serious interest in optics seems to have started some twenty years ago. In 1934 he published a diffraction theory of the Foucault knife-edge test for the figure of astronomical telescope mirrors. This work was notable on two counts: for the discovery of the so-called circle polynomials (now widely, and rightly, known as Zernike polynomials), and for the introduction of the method of phase contrast. Almost immediately Zernike realized that the same method could be used in the other extreme of optical instruments, namely, the microscope. The fruitful results of this invention, especially in biological work, are both sufficiently widely known and appreciated to require no comment. This being so, it is easy to forget Prof. Zernike's other contributions to optics. His work, and that of his pupils, on the diffraction theory of aberrations, the experimental study of these effects, the use of the method of the 'coherent background' in diffraction, and the theory of partial coherence, equally constitute an outstanding contribution to our present knowledge of optics. Prof. Zernike is well known in Britain. He has delivered the Thomas Young Oration of the Physical Society, and in 1952 he was awarded the Rumford Medal of the Royal Society.

Royal Society: Award of Royal Medals

H.M. The Queen has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1953 as follows: to Sir Paul Fildes, O.B.E., F.R.S., for his classical researches on growth factors for bacteria and for laying the foundation of work leading to a rational approach to chemotherapy; to Prof. N. F. Mott, F.R.S., for his eminent work in the field of quantum theory and particularly in the theory of metals.

Metrology at the National Physical Laboratory, Teddington: Mr. F. H. Rolt, O.B.E.

Mr. F. H. Rolt, who has retired from his post as the superintendent of the Metrology Division of the National Physical Laboratory, Teddington, has been associated since 1912 with the laboratory's work in the field of engineering metrology and standardization. During the First World War the widespread application by the Ministry of Munitions of the principles of interchangeable manufacture placed enormous demands upon the Laboratory for verifications of reference standards and gauges, and for the development of methods and apparatus for the precise measurement of dimension and shape. Appreciation of the economic advantages of quantity production gave rise later on to studies in the Metrology Division of the basic principles underlying suitable design of interchangeable components and the efficient control of such products by accurate gauging or measurement during manufacture. Mr. Rolt was responsible for the prosecution of many of these studies, and for several developments of methods and apparatus now widely adopted in the practice of engineering inspection. His "Gauges and Fine Measurements", published in two volumes in 1929, achieved world-wide renown and appreciation. In 1941 he was seconded to the Ministry of Supply (Machine Tool Control), in which he served until the end of the Second World War, first as director of gauges and measuring instruments and later as director of jigs, tools and gauges. For these services he was made O.B.E. He succeeded Mr. J. E. Sears as superintendent of the Metrology Division in 1946. Mr. Rolt has contributed much to the work of numerous committees of the British Standards Institution and of other organizations, both national and international, concerned with the establishment of engineering standards. He took a leading part in the post-war American–British–Canadian conferences, one of which led to the adoption of the unified screw thread. He is also keenly interested in the education of engineering students and apprentices, and was instrumental in introducing engineering metrology as a subject for the Higher National Certificates in mechanical and production engineering.

Dr. H. Barrell

Mr. Rolt is being succeeded by Dr. H. Barrell. Dr. Barrell was educated at the Royal Grammar School, High Wycombe, and the Royal College of Science, London, where he studied physics and later specialized in spectroscopy. He joined the staff of the National Physical Laboratory in 1923, and was associated

with Mr. Sears, of the Metrology Division, in determinations of the metre and the yard in wave-lengths of light, and of the refractive index and dispersion of air. In recent years he has had charge of research work in the Division into optical and microwave interferometry, directed towards improving the precision of length measurements, and he has published many papers on this subject, particularly since the War. Though his work has been chiefly on the physical side of the Metrology Division, Dr. Barrell has had considerable experience of engineering metrology, especially since 1939. During the War he successfully adapted the pneumatic gauging principle in machines for simultaneous multiple inspection of several dimensions on certain types of ammunition, and this principle was later applied by him to the measurement of variations from uniformity of wool and cotton between the carding and spinning operations.

Department of Ethnography, British Museum: Mr. H. J. Braunholtz, C.B.E.

Mr. H. J. Braunholtz retired from the keepership of the Department of Ethnography in the British Museum, London, on October 12. A member of St. John's College, Cambridge, Mr. Braunholtz studied classics and modern languages, graduating in 1911, and became an assistant keeper in the British Museum in 1913 under the late Captain T. A. Joyce, who was head of the Ethnographical Section of the Department of Oriental Antiquities and Ethnography. In 1938 Mr. Braunholtz was appointed keeper of the Department, and, when ethnography was made a separate department in 1945, he became its first keeper, so that, apart from the period of the First World War when he served in the R.A.M.C., practically the whole of his working life has so far been devoted to the Museum. When he entered the Museum, the staff was very small, and he was responsible for the registration of material from the whole field covered by his Department. A conscientious and exact scholar, he made the most of his opportunities and developed an extremely wide and detailed knowledge of the vast ethnographical collections of the Museum, and through them of the customs and habits of their makers. The collections include particularly fine series of objects from the ancient civilizations of Central and South America, a subject particularly dear to the heart of his old chief, Joyce, and Mr. Braunholtz followed him in making this a special interest. Apart from ancient America, he gave particular attention to the Pacific and Africa south of the Sahara, and his knowledge was deepened by field trips to East and South Africa, where he did not confine himself to the work of modern peoples but also made on his own account a large and well-documented collection of stone implements, which he afterwards gave to the Museum. A later visit to West Africa on behalf of the Colonial Office resulted in recommendations which led to action to preserve examples of the art and material culture of the peoples of the West African Colonies, including the establishment of museums. Another result of his trip was that the Oni of Ife kindly allowed his famous series of bronze heads to be taken to England for treatment and temporary exhibition in the Museum. Outside the Museum, Mr. Braunholtz has rendered conspicuous service to the Royal Anthropological Institute as a member of the council, honorary editor and president for two terms. He was made C.B.E. in 1951.

Mr. A. Digby

Mr. Braunholtz is succeeded as keeper by Mr. Adrian Digby, who graduated from Brazenose College, Oxford, where he also obtained the diploma in anthropology. Mr. Digby entered the Museum as an assistant keeper in 1932 and was appointed deputy keeper of the Department of Ethnography shortly after the end of the Second World War. During the War he worked for Naval Intelligence and was for a time attached to the Hydrographic Department of the Admiralty. The areas which have claimed most of his attention are Oceania and America, and he specializes in the archæology of Central America. He is also particularly interested in various aspects of technology, including sailing and navigation, of which he has practical experience. After representing the Museum at the Twenty-ninth International Congress of Americanists, held in New York in 1949, Mr. Digby made a tour of museums in the United States in order to study methods of display and other museum techniques. When the Ethnographical Gallery of the British Museum was reorganized after the War, his exhibits of American archæology and ethnology pointed the way to the arrangement of the whole gallery.

Atomic Energy in Great Britain

The White Paper on the future organization of the United Kingdom Atomic Energy Project (Cmd. 8986; pp. 10; London: H.M.S.O., 1953; 6*d*. net) summarizes the main recommendations of the Committee set up last April, with Lord Waverley as chairman, "to devise a plan for transferring responsibility for atomic energy from the Ministry of Supply to a non-Departmental organization and to work out the most suitable form for the new organization, due regard being paid to any constitutive and financial implications". These recommendations have been accepted by the Government, although the report itself will not be published in full because it deals with many matters which, for reasons of security, cannot be disclosed. They include the establishment of an Atomic Energy Corporation, as a statutory corporation, with an executive board and carrying the responsibility for the establishments at present controlled by the Atomic Energy Research Establishment, by the Production Division of the Ministry of Supply and by the Atomic Weapons Research Establishment, although the Ministry of Supply will retain responsibility for the conventional components of atomic weapons. The Waverley Committee suggested that the Lord President of the Council was the most suitable Minister, of high Cabinet rank and with no departmental responsibilities encroaching on the field of atomic energy, to be designated as responsible to Parliament for monies provided for the Corporation and for policy directions given to the Corporation, and this suggestion has been adopted by the Government. The Lord President of the Council will also be chairman of the Ministerial Committee, representative of all Ministerial Departments concerned with various aspects of atomic energy. The Ministry of Defence will remain generally responsible for the allocation of resources available for defence purposes between atomic weapons and conventional arms, and for the distribution of effort between the research, development and production of atomic weapons.

Administrative preparations for giving effect to the Committee's recommendations are being made.

An Order in Council transferring responsibility for atomic energy from the Minister of Supply to the Lord President of the Council as from January 1, 1954, will be laid before Parliament, and later a Bill will be introduced to provide for setting up the Corporation. It is proposed that the chairman of the Board of the Corporation will act as general manager, and the Board will include four whole-time functional directors: for engineering and production; for weapons; for research; and for administration and finance. Two part-time members with no separate technical function are also proposed. It is emphasized that salaries offered by the Corporation should not be seriously out of scale with those paid by other public corporations, and it is suggested that the staff of the atomic energy undertakings should be seconded to the Corporation at the vesting date for an initial period which might extend to two years, during which they would retain their Civil Service status unimpaired. Before the end of this period, the Corporation would be expected to offer individuals employment on appropriate terms which they would be free to accept or decline. Security would be primarily the responsibility of the Corporation, subject to the right of the designated Minister to satisfy himself as to the working of the arrangements. The White Paper stresses two points in conclusion: first, overall policy will remain firmly in the hands of Government, and objectives and policy will be determined by Government directives; second, the rights and interests of existing staff will be fully respected, and consultation with staff representatives will take place at the appropriate time.

New Publications Facilities of the Chemical Society

The Chemical Society has recently announced plans for two new services to be available from next January to Fellows of the Society and others. The Society is to commence the publication, under the title of *Current Chemical Papers*, a monthly world list of new papers in pure chemistry. The entries will include titles of papers (expanded where necessary), the authors' names and the references to the original journal, and will be classified into the principal branches of chemistry under some twenty different headings. This publication is not intended to become a substitute for an abstracting service, but it is designed to advise research workers of newly published papers more rapidly than would be possible in a journal publishing full abstracts. There will be no index. The price for Fellows will be 25*s*. a year (as part of their publications allowance), and for outside subscribers it will be £2 10*s*. a year. The second scheme which the Society has introduced is that offprints will be made available of individual papers published in its *Journal*. The *Proceedings* of the Society (which is issued free each month with the *Journal*) will contain lists of papers which have been accepted for publication and will normally be published in the *Journal* during the succeeding two months. Thus, by ordering the reprint promptly, it will be possible to obtain it at about the same time as publication. Fellows are invited to pay 30*s*. (as part of their publications allowance) for one book of thirty vouchers, valid for one year only, each of which can be exchanged for one reprint of any paper selected from the *Journal*. Additional vouchers (valid for three years) are available outside the publications allowance for Fellows and also for libraries and other subscribers to the *Journal* at 10*s*. per book of five vouchers. Single reprints can also be purchased by any applicant at 5*s*. per reprint.

Library Classification of Zoology Books

A communication from Prof. R. Denison Purchon, Raffles professor of zoology, University of Malaya, Singapore, where the Library of Congress Classification has been adopted in the new Library which has recently been built, directs attention to certain features of the Zoology Section of that Classification which urgently need revision. He points out that a small library may work efficiently by a classification of books according to their location on the shelves; but in a larger library it is desirable to retain flexibility of expansion, and to gain the maximum assistance from the experience of other libraries, by adopting one or other of the main systems in use. It is recognized that the purpose of a library classification is to enable the student to find a book with ease, by reference to catalogues. It must be borne in mind, however, that many university students, receiving little or no instruction on the proper use of a library catalogue, prefer to search for their books on the shelves rather than in the catalogues. Such browsing has definite advantages to the student though it may be undesirable from the librarian's point of view; but it does indicate the need for a logical arrangement of books on the shelves. The Library of Congress Classification is partly systematic, and partly alphabetical. An alphabetical treatment is suitable for minor details; but Prof. Purchon directs attention to the confusion arising when it is applied to a super-phylum such as the "Vermes", and to the undesirability of mixing the phyla and their sub-divisions alphabetically. The treatment of the Insecta is also criticized, and the placing of the Prochordata in the Vertebrata. The sub-divisions of the sections on botany and zoology do not provide the expected sub-sections for animal physiology, animal ecology, evolution of animals, and genetics in the zoology section. References to physiology are scattered systematically; but it is a matter of opinion whether physiological work should be in an appropriate systematic position or collected. Prof. Purchon also points out that work on animal ecology warrants the inclusion of the headings 'terrestrial', 'fresh water' and 'marine', and criticizes the omission of headings for the evolution of animals, and for animal genetics.

Research Essay Competition

A criticism that is often voiced with regard to technical development in Great Britain is that many new ideas which originated in British laboratories were not followed up at the time and were later exploited in other countries. One of the difficulties in the way of further advance is the gulf between the industrial scientist and the essentially non-technical board of directors of the firm which he serves. First, industrial scientists are often not able to describe their work and its potential applications in simple concise terms; secondly, they do not often appreciate the relationship of their own work to the broad economic purpose of their firm. As a contribution in overcoming these difficulties, the scientific advisory board of the journal *Research* is sponsoring an essay competition for which prizes of £100 and £50 will be offered, with a special prize for the best entry from a competitor less than thirty years of age.

Entrants will be required to submit an essay describing any recent advance in science (whether their own work or the published work of others) and discussing the potential applications and industrial development of the work; it should be emphasized that the word 'industrial' is to be read in the broadest sense, including such fields as agriculture, etc. Proof will have to be given that the entrant was actively engaged in scientific research during the period November 1, 1953–June 30, 1954. Essays must be submitted by June 30, 1954. Joint entries by not more than two competitors may be submitted. Further details of the competition can be obtained from *Research*, Butterworths Publications, Ltd., 88 Kingsway, London, W.C.2.

Since these prize offers were announced, the *Sunday Times* has offered two further prizes of £100 and £50 for the two best entries considered by the Editor, in consultation with the Advisory Board of *Research*, suitable for publication in a general newspaper and dealing with certain set topics. Further information can be obtained from either *Research* or the *Sunday Times*.

B.C.G. Vaccination of School Children

A CIRCULAR dealing with the vaccination of school children with B.C.G. vaccine has recently been sent to local health authorities by the Ministry of Health. The circular refers to a previous one, and it was after the issue of this latter document that the Minister of Health approved proposals by the local health authorities to enable B.C.G. vaccination to be given to persons known to have been in contact with tuberculous infection. The present circular states that the Minister is now ready to approve the offer of B.C.G. vaccination to school children during and, if possible, towards the end of the year preceding their fourteenth birthday. This extension of the vaccination to school children should not, however, prejudice the scheme for the vaccination of contacts, which should continue. The local health authority will decide, after consultation with the local education authority, whether to extend this vaccination to the school children specified. For their guidance a medical memorandum which has been issued by the Ministry (No. 324 BCG) and discusses the value of B.C.G. vaccination and the techniques to be used by vaccinators, is being sent direct to medical officers of health. The circular states that vaccination should be carried out by designated medical officers on the responsibility of the medical officer of health after consultation with the school medical officer. Most of the vaccinations will be done during the child's penultimate year at school, so that it will be possible to follow up each vaccinated child for at least a year. Children who stay at school after the age of fifteen should also be vaccinated not later than their fourteenth year. The consent of the parents must be obtained before vaccination is done. If the parents are anxious about the vaccinated arm, they may consult the school medical officer or the chest physician, who will consult the family doctor. Talks and discussions are suggested to eliminate fear or misunderstanding of the vaccination. Before the vaccination scheme is extended in the manner just described, local authorities are asked to give the Minister of Health an outline of the way in which they propose to extend the scheme and a statement of the areas to be covered and the measures to be taken for the tracing and vaccination of contacts.

Scottish Marine Biological Association: Millport Laboratory

ON November 11 the reconstructed public aquarium at the Scottish Marine Biological Association's Millport Laboratory was opened by Dr. J. R. Peddie, secretary and treasurer of the Carnegie Trust for the Universities of Scotland. The original aquarium, constructed in 1904, had served the dual purpose of a public aquarium and tank room for research. It had long been out of date, and three years ago was closed to the public. The Carnegie Trust for the Universities of Scotland had previously made a grant of £600 a year for five years to cover the construction of a new public aquarium. This has now been achieved, while a separate tank room and aquarium is provided for the use of the scientific workers. The general plan of the public aquarium is the work of Mr. E. Ford, director of the Laboratory, while the internal design of rock is that of Dr. R. B. Pike, principal scientific officer at Millport. A large number of people representing numerous bodies interested in all aspects of the work at Millport attended the opening ceremony, at which the chair was taken by the president, Prof. C. M. Yonge. It is interesting to note that this newest of all public marine aquaria was opened one hundred years after the first such aquarium, due to the enthusiasm of Philip Henry Gosse, was opened, on May 21, 1853, in the Zoological Gardens, London.

The British Trust for Ornithology

IN addition to twenty-first birthday greetings from many distinguished ornithologists from Great Britain and countries overseas, members of the British Trust for Ornithology should welcome the news from the honorary treasurer that the satisfactory financial position will enable the Trust to extend its inquiries. This is referred to in the report for 1952, which shows that the Trust's membership is continuing to grow. The report contains a valuable statement by Dr. David Lack, director of the Edward Grey Institute, describing the Trust's part in the launching of the Institute and their present relationship. Work undertaken on behalf of the Trust is also referred to and shows that, in 1952, more heronries were reported than in 1951 and that about 1,500 more nest records were recorded in 1952 than in 1951. The sample census of great crested grebes has been continued, and shows that in 1951 a record total of adult birds was observed. The black redstart inquiry was continued, and confirmed that thirty-one pairs of these birds bred in England in 1951, while seven more pairs were present but not proved to breed. For the first time on record singing males occupied territories in Scotland. Investigations have also been made into the birds of high-level woodlands, the breeding distribution and habitats of the pied flycatcher, and the wintering of gulls in Britain. Details of the ringing scheme show that more than ten thousand more birds were ringed in 1952 than in 1951. The report also contains an account of the work of the Edward Grey Institute during April 1952–April 1953.

Documentation in Aeronautics Research

AT the second meeting in London during September 3–4 of the Documentation Committee of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization, it was decided that the activities of the Committee should be given the fullest possible publicity in the aeronautical field. The aims and work of the Documenta-

tion Committee are related to and conditioned by the aeronautical information activities of governments, industrial organizations, research institutes and technical associations, and it was resolved accordingly that the proceedings of the Committee should be made available to all interested agencies in each country. Inquiries regarding, or comments on, the work of the Committee should be sent to the Chief Information Officer, Royal Aircraft Establishment, South Farnborough, Hants. The agenda of the first two meetings included such items as standardization of the size and format of documents, the provision of catalogue cards with reports, the improvement of existing abstracting services, particularly in respect of coverage and elimination of duplicate effort, and research into documentation. Proposals for the classification of aeronautical literature were considered, including the development of the aeronautical sections of the Universal Decimal Classification and trial of the scheme by the Natienaal Luchtvaart Laboratorium (Holland) for cataloguing aerodynamic data; and the United Kingdom delegates indicated that careful experiment will be made both into the use of the cards thus provided and into the problems involved in producing similar cards for security-graded classified reports issued in the United Kingdom. The production of an up-to-date aeronautical interlingual dictionary in English, French, German, Italian, Russian and Spanish, based on the British Standards Institution's glossary of aeronautical terms, was also discussed.

Pleistocene Correlation and Nomenclature

At the Fourth Congress of the International Association on Quaternary Research, held in Rome and Pisa during August–September, the following committee was appointed to consider regional and world-wide problems of Pleistocene correlation and nomenclature: *Chairman*, Prof. I. M. van der Vlerk (Leyden); *Secretary*, Prof. E. Tongiorgi (Pisa); Prof. C. Arambourg (Paris), Prof. R. F. Flint (Yale), Dr. K. P. Oakley (London) and Prof. P. Woldstedt (Bonn). The committee will be assisted by a number of corresponding members. Its first task will be to collect the views of specialists in different parts of the world on the question of the subdivision of the Pleistocene. The secretary (at Via Luca Ghini 2, Pisa) would be glad to receive any relevant suggestions.

The Free University of Berlin

An article in *Science* (118; 1953) by Prof. W. O. L. Heubner, of the Free University of Berlin, gives a first-hand account of events in the University of Berlin while under Nazi and, later, Communist control. Under Russian control it became clear that the University of Berlin would not be tolerated as an institution of higher learning for its own sake; it was used as a means of educating 'specialists' who would serve the advancement of the 'working' people, subjects like religion, law, history, Greek and Latin becoming superfluous. Student organizations were controlled by indoctrinated pro-Communist enthusiasts. Prof. Heubner also describes how the Free University of Berlin came into being in 1948.

Mineralogical Society: Officers for 1953–54

The following have been elected officers of the Mineralogical Society for 1953–54: *President*, Dr. J. Phemister; *Vice-Presidents*, Dr. F. A. Bannister and Dr. F. Dixey; *Treasurer*, Prof. J. H. Taylor; *General Secretary*, Dr. G. F. Claringbull (c/o Geological Society, Burlington House, Piccadilly, London, W.1); *Foreign Secretary*, Dr. L. J. Spencer; *Editor of the Journal*, Dr. L. J. Spencer.

Announcements

Dr. S. J. Folley, head of the Physiology Department of the National Institute for Research in Dairying, Reading, has been appointed a visiting professor in the Collège de France, Paris, for the month of December. He will deliver a course of six lectures on "La Physiologie et la Biochimie de la Sécrétion lactée".

Dr. W. Roman has been appointed head of the Division of Biochemistry at the Institute of Medical and Veterinary Science in Adelaide, South Australia; he will carry out research on metabolic problems in co-operation with the medical and veterinary professions. He will continue to edit *Enzymologia*.

The Wellcome Research Library of the Royal Society of Medicine will be opened officially by the Marquess of Salisbury, the Lord President of the Council, at 2.30 p.m. on December 4, 1953, in the Barnes Hall. Admission will be by ticket, obtainable from the Assistant Secretary of the Society.

The first Middleton Memorial Lecture, organized by the Trustees of the Sir Thomas Middleton Memorial Trust, will be delivered by Sir James Scott Watson in the Senate House of the University of London on December 10 at 5.30. The title of Sir James's lecture will be "The State and Agriculture (with special reference to Thomas Hudson Middleton's contribution to the development of agricultural education and research)". The chair will be taken by Dr. Norman C. Wright. The lecture is open to the public.

Under the auspices of the American Philosophical Society, Philadelphia, and the National Academy of Sciences, Washington, an effort is being made to bring together in book form all that is known of John Abbot's life and of his work as a student and delineator of American birds. Miss Elsa G. Allen, of the New York State College of Agriculture, Cornell University, Ithaca, New York, would be grateful for information which may help to throw light on the history of this remarkable man. Information as to the present whereabouts of any of his illustrations would also be welcomed.

The Société Chronométrique de France, with the support of the corresponding bodies in Belgium, Germany, Great Britain and Switzerland, is organizing an international congress of chronometry, to be held in Paris in the spring of 1954. The congress will not be restricted to horology but will cover all aspects of the measurement of time, including the determination of intervals of time and of the quantities derived from them, questions of frequency, speech, acceleration, etc. Those interested should write to Prof. R. Baillaud, president of the Société Chronométrique de France, director of the Observatoire National at Besançon, Doubs, from whom further details can be obtained.

Erratum. In the communication entitled "Influence of Cysteinamine, Methylamine and Cortisone on the Toxicity and Activity of Nitrogen Mustard", by Dr. O. Peczenik, in *Nature* of September 5, p. 454, par. 2, line 14, for "0·125 gm." read "0·125 mgm.".

BIOLOGICAL RHYTHMS

THE fourth conference of the International Society for the Study of Biological Rhythms took place at the University of Basle during September 18–19. One hundred and twenty-two participants from ten countries heard and discussed forty-two papers dealing with many aspects of biological periodicity.

Prof. F. Georgi, the able local organizer, opened the proceedings.

Following the philosophy of Klages, E. Frauchiger (Berne) indicated the important part which the concept of rhythm plays in the arts and sciences. Contrasting rhythm and beat (*Takt*), he defined the former as the "similar repetition of similar events". K. Wacholder (Rostock), reviewing the physiological field, also stressed the flexibility of biological rhythms, which is absent in many physical models and simple machinery. He discussed in considerable detail the different ways in which rhythmic activities may originate. F. Gerritzen (The Hague) considered biological rhythms as regular alterations of a continuous metabolic flow in an open system.

Mathematical methods for the measurement of period length were discussed by T. Bartels (Göttingen), who based his deliberations on formally similar geophysical and sunspot measurements. A. Sollberger (Stockholm) discussed certain statistical proceedings when testing biological data for the 24-hr. period, while G. Oberhoffer (Bonn) described a new optical method for the frequency analysis of graphs. T. Blume (Düsseldorf) claimed that an ingenious adaptation of Fourier analysis enables him to detect relevant periodic components from fairly short-time series of measurements. Clinical applications of this approach were reported by W. Menzel (Hamburg), who pointed out that disease is often accompanied by a loss of physiological rhythms, which are characteristic for many bodily functions (for example, temperature, sleep, renal function) during health. Thus rigidity of organ functions as well as more serious breakdowns are both signs of a decreased homeostasis. Recovery after illness (for example, from tuberculosis), as E. Dissmann (Klagenfurt) pointed out in the discussion, is frequently accompanied by the resumption of the physiological rhythms.

From the botanical field, which has always been leading in studies of biological periodicity, E. Bünning (Tübingen) reported in particular on the connexion which seems to exist between the long-known phenomena of diurnal leaf movements and of photoperiodicity. The effects of light and darkness on growth and flowering depend on the momentary adaptation of a plant of which its leaf position is yet another indication. This applies both to long- and short-day plants. A. Remane (Kiel) discussed some exogenous and endogenous factors which produce the great fluctuations in numbers, known to occur in arctic and in marine animals. He pointed to the complexity of such fluctuations and to their connexion with periodic migration and epidemics.

H. Kalmus (London) listed some examples of differential responses of genetically differing individuals of polymorphic species to time of day or season. Among the former he mentioned the colour variants of female *Colias* butterflies and among the latter the chromosomal races of *Drosophila pseudoobscura*. He also discussed the genetical implications of temporal isolation and of the cyclomorphosis of Rotifers and Cladocera. G. P. Wells (London) discussed the very regular changes of water in the tubes and burrows of sedentary polychætes, which are unconnected with any environmental rhythms; he described ingenious techniques for their recording. O. Köhler (Freiburg) talked about the rhythmic activities in bird song and behaviour and on certain mechanisms in birds and bees which compensate for the daily movement of the sun and thus make navigation possible.

C. P. Richter (Baltimore) showed cycles of several weeks duration in the behaviour and physiology of rats, which occurred after thyroidectomy, during sulphamerazine treatment or after the application of radioactive iodine. Interference with the posterior lobe of the pituitary produced fourteen-day cycles, whereas removal of most of both ovaries often resulted in cycles of ninety days period length. Experiments concerning adrenal cycles of mice and of men were described by F. Halberg (Minneapolis), who then compared adrenal and sexual cycles. T. Staehelin (Basle) reported some success in treating certain rigidly rhythmical manifestations of schizophrenia by various means affecting the brain stem, which he considers to be the region responsible for many rhythmic activities.

H. Reimann and H. Zellweger (Beirut) directed attention to an alarming, if benign, condition, sometimes called 'periodic disease', which by its familial occurrence and by the fact that almost exclusively Armenians and Jews are affected seems to suggest some hereditary basis, but is otherwise of unknown etiology.

Some complexities of circulatory rhythms were discussed by E. Rothlin and A. Cerletti (Basle), while P. Vara (Helsinki) showed the first recorded ECG of an unborn human fœtus. H. Mislin (Basle) demonstrated encephalograms of Cephalopods; G. K. Döring (Tübingen), E. von Philippsborn (Oberstdorf) and others discussed rhythm in respiration. T. Petrèn (Stockholm) described fluctuations in the glycogen content of chick embryos.

Among the factors which influence biological rhythms, W. Frey (Berne) discussed observations and experiments concerning the influence of air ionization on the circulation, while several others discussed the interactions of hydrotherapeutic methods and sport activities with body rhythms.

Problems of the 24-hr. periodicity were attacked from many angles. T. N. Mills and S. W. Stanbury (Manchester) described diurnal variations in the excretion of various substances by the renal tubules. T. Aschoff (Heidelberg) discussed some methods by which external rhythms (for example, temperature, light, noise) can be shown experimentally to be in control of diurnal activities of organisms. A. Kilbinger (Essen) showed that one such factor—important in plant life—may be a greatly increased carbon dioxide content at night of the air above soil.

N. Kleitman and T. G. Engelmann (Chicago), in a description of the development of the sleep–wakefulness pattern, showed that, contrary to a

widely held belief, the total duration of a baby's sleep does not change up to the twelfth week, but that the day fraction of sleep, which is the smaller from birth, decreases. During the succeeding fourteen weeks the duration of night sleep remains unchanged; but day sleep decreases further until an adjustment to the infant's environment is reached; this consists in one long unbroken period of night sleep and short morning and afternoon naps. H. R. Richter (Basle) stated that sleep and wakefulness, like youth and age, entail different brain rhythms, a fact which can be used for the investigation of sleep. A. W. Eiff (Bonn) succeeded, by altering the clock during a short period of anæsthesia, not only in deceiving the time-sense of people living in a constant-condition room, but also found a shift in certain diurnal body rhythms, though not in others. D. Lüderitz (Münster) showed that thyrotoxic and myxœdematous patients differ from healthy people in their resistance to sleep-disturbing noises. T. Möllerström and S. Svensson (Stockholm) described the diurnal rhythms of various types of diabetes and stressed the success of the adjustment of therapeutic measures to those rhythms. In a more general way this principle was supported by W. Menzel and A. Jores (Hamburg).

G. Metz and P. Andlauer (Strasbourg) reported that in certain selected industries fewer accidents occurred during night shifts than during day shifts, while A. Pierach (Nauheim) described the adverse effects of night work and of frequent changes of working hours, especially on diseased people.

It is hoped that—as was the case after the last conference—the papers and discussions of this conference will be published in a supplement to the *Acta Medica Scandinavica*. Profs. A. Jores and W. Menzel, of Hamburg (2. Medizinische Klinik), were elected president and secretary of the Society. A sub-committee on terminology was also elected. The next conference will be held in Stockholm in 1955.

H. Kalmus

ORGANO-PHOSPHORUS INSECTICIDES

A SYMPOSIUM on organo-phosphorus insecticides, arranged jointly by the Crop Protection Panel of the Society of Chemical Industry, the Association of Applied Biologists, the Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists and the Pharmacological Society, was held at the Imperial College of Science and Technology, London, on the morning and afternoon of October 2. The meeting attracted a large audience, more than filling the large Chemistry Theatre of the College.

The large attendance may have owed more to the participation of four learned societies than to the choice of a topical subject which is much in the scientific news, because the open discussion was not as lively as one might have expected, only a small proportion of those present participating. Coming so soon after the much more active two-day discussion on "Anti-cholinesterases", organized by the British Pharmacological Society and the Society of Chemical Industry, which was held during March 27–28, one wonders whether the subject is not a little 'played out'. A more likely explanation, however, of the somewhat apathetic discussion may have arisen from the fact that so many societies were interested. One feels that their representatives on the joint committee may have been too polite to press their own interests, with the result that the five invited lecturers presented a rather incoherent display, and the audience was left wondering what were the most important arguments in which they were expected to participate.

There is unquestionable good in different societies coming together for such symposia, but it is more important than when they meet alone that the subject-matter should be selected and restricted, and a clear field of controversy mapped out. Granted this greater care of planning, which is clearly a more difficult task for an *ad hoc* joint committee, meetings of the most diverse societies can be very successful. Where this is lacking, there tends to be a diffidence on the part of the various contributors to discuss the particular aspects of the most interest to them in the presence of representatives of other professions, who they feel may not be particularly interested. It was this factor, I think, which tended to discourage the discussion on this occasion.

The morning session was devoted to toxicology: a paper prepared by Dr. K. A. Lord and Dr. C. Potter, of the Rothamsted Experimental Station, was read by the former, dealing with the insect aspect, and one by Dr. J. M. Barnes, of the Medical Research Council Toxicology Research Unit, Carshalton, dealing with the mammalian aspect. Prof. V. B. Wigglesworth (Cambridge) took the chair.

Prof. Wigglesworth spoke of the importance of biological interactions in the control of insect pests and the importance, therefore, of species-selective insecticides, as well as of the necessity for selectivity of a wider kind in the choice and development of insecticides less poisonous to man. He emphasized that a great deal is still to be learned about the biochemistry of selectivity. The systemic insecticide 'Schradan' is highly selective, but the mechanism is far from clear. Phytophagous caterpillars are notoriously immune, and, although they possess an unusually alkaline gut content, this can scarcely account for rendering innocuous a substance very resistant to alkaline hydrolysis. Something much more subtle is involved. Systemic insecticides also pose new problems in the matter of safety to man, since an insect poison incorporated into the structure of the plant is something new.

Dr. Lord said that, although the function of acetylcholine in myoneural transmission in mammals is well established and the toxic action of the organophosphorus compounds is undoubtedly mainly due to their inhibition of cholinesterase, even the existence of acetylcholine is not clearly established in insects, and it is far from certain that it has any important part to play. He felt, therefore, that the scope of investigation in insects should be widened to include other esterases which are also inhibited by the organo-phosphorus compounds. Crude extracts from insects have considerable activity in hydrolysing phenyl acetate, which has been used as a substrate in many experiments.

No general correlation has been established between insecticidal activity of various compounds and their ability to inhibit either cholinesterase or the general esterase *in vitro*. This is doubtless due to prior conversion of the compound *in vivo* as in the case of pure 'Parathion', which does not inhibit either esterase *in vitro* but is converted in *Tenebrio molitor*

to a compound which does. In other cases lack of correlation may be due to physical factors, such as membrane permeability and partitioning between aqueous and lipoid phases, and it must be remembered that the enzymes are localized *in vivo* and that this localization is necessarily lost in making a crude extract.

Some organo-phosphorus compounds are toxic to insect eggs, although insufficiently in most cases to be of practical importance. Extracts of tomato moth eggs do not hydrolyse acetylcholine unless made from eggs in a late stage of development. Extracts from all stages hydrolyse phenyl acetate. Tetraethyl pyrophosphate (TEPP) at high concentration kills eggs at all stages, suggesting that the toxic action is exerted via the general—rather than the choline—esterase.

Dr. Barnes divided his description of the information on organo-phosphorus poisons on mammals into three parts: first, the acute effects and death; second, long-term and chronic effects; and third, the inhibition of cholinesterase. All cases of death are finally directly due to inhibition of respiration caused by the failure of neuro-muscular transmission, in most cases at both ends of the nervous system; but it is to be noted that some compounds, for example, 'Schradan', produce very little effect on the brain cholinesterase at the time of death, and in such cases failure of transmission may be confined to the muscle end of the nerve system. Fatal outcome can in many cases be avoided by application of artificial respiration until the internal mechanism of respiration has recovered, but the success of this depends on the reversibility of the cholinesterase inhibition. Different compounds differ in this respect; for example, among the phosphoric esters with an active group, those where the stable groups are methoxy are more easily reversed than where they are ethoxy, which in turn are very much more easily reversed than where the *iso*poproxy is concerned; and, in fact, artificial respiration fails to produce recovery after intoxication by di-*iso*propyl from the phosphonate.

In describing the long-term and chronic effects, Dr. Barnes again directed attention to the importance of reversibility, and mentioned also the prolonged paralytic effects resulting as a delayed action after severe intoxication with some compounds. This delayed action, which has operated in man, has not done so in the smaller mammals but can easily be experimentally demonstrated in birds. Unfortunately, the common factor among the compounds which produce this effect cannot be indicated, and so the probability of its occurrence must be determined entirely empirically.

In the case of mammals there is no doubt that the inhibition of cholinesterase is primarily responsible for the external symptoms; but as with insects, though in less degree, other esterases may be involved, and in fact it has been known for some time that the pseudo cholinesterase of serum is more effective in hydrolysing some other esters of choline than acetylcholine itself.

Dr. B. A. Kilby, of the School of Medicine, University of Leeds, opening the discussion, said that the mystery of 'Schradan'—a toxic substance not inhibiting *in vitro*—has been largely cleared up, oxidation to the amide oxide, an inhibiting and easily hydrolysed intermediate, being responsible. He felt that we should not be too afraid of compounds of high initial toxicity if they are quickly destroyed, and wondered whether the time has not come when we could contemplate the use of more toxic rather than less toxic insecticides.

During the discussion which followed, Dr. P. P. Hopf described some work in which the specific action of organo-phosphorus compounds against different enzymes appears very clearly. He has found, in working with diethyl phenyl phosphates, that the compound with chlorine substituted in the ortho position is very much more effective against the general esterase, while that with chlorine substituted in the para position is much more effective against cholinesterase. At a later stage of the discussion, Dr. W. N. Aldridge emphasized the extreme importance of chemical purity when examining the effect of organo-phosphorus compounds on enzymes *in vitro*, when there is a possibility of the compound under investigation being contaminated with a very much more active one. For example, esters of diethyl phosphoric acid are frequently contaminated with the extremely active inhibitor, tetraethyl pyrophosphate.

Dr. D. F. Heath pointed out that many of the reversible anti-cholinesterases depend for their absorption on the precise geometrical fit of two active centres in the molecule, and their specificity for different enzymes could doubtless be due to this stereochemical factor; whereas the majority of the organo-phosphorus inhibitors become covalently linked to one active centre in the enzyme, involving disruption of a link in the original compound. In this case, a lower degree of selectivity is to be expected, arising from modification of reaction-rates, influenced rather less drastically by stereochemical factors.

Taking up Dr. Kilby's query about the use of more highly toxic compounds, Dr. E. F. Edson discussed the human safety aspect. He emphasized that the relative toxicity to mammals and insects is important, and the new insecticide 'Malathon', having about a hundredth the toxicity of 'Parathion' to mammals and about a quarter of its toxicity to the majority of insects, can be regarded, therefore, as having a twenty-five-fold factor of safety in use. He was particularly concerned with the volatility of toxic compounds in regard to the risks of their use in the field, because the obvious protective measure, namely, the respirator, is an uncomfortable device under hot, sunny conditions, and workers are very inclined to evade its use. He mentioned that the safety aspects of 'Schradan' have been very fully investigated. His own information on rats and pigs indicates that a daily intake of about one two-hundredth of a lethal dose produces scarcely any detectable effect. Alone among the insecticides, this compound has been used to a considerable extent for therapeutical purposes (notably by Ryder and DuBois in the United States) in treatment of myasthenia gravis, and, although doses have been used requiring the additional use of atropine, many patients have been able to return to normal activities.

The afternoon session was concerned mainly with analytical aspects, under the chairmanship of Dr. J. R. Nicholls. Dr. G. S. Hartley, of Pest Control, Ltd., dealt with the behaviour of 'Schradan' in the living plant. Several lines of evidence lead clearly to the conclusion that the biochemical attack is in the first place an oxidation of a peripheral group in the molecule, and that it is probably basically similar to the oxidation occurring in the mammalian liver, but the conversion is very much slower. Oxidation of 'Schradan' in inanimate systems has also been

examined, and recently Spencer and O'Brien in Canada have examined the effect of partial chlorination in anhydrous systems. Oxidation always produces an active inhibitor of cholinesterase, but one which is very unstable in water and leads to complete inactivation of the molecule by hydrolysis or partial conversion to a less active compound. Many steps in the oxidation are possible, as in the case of oxidation of simple tertiary amines, and the whole sequence of chemical processes is likely to be complex; but all the evidence points to each successive step of oxidation producing a compound yet more unstable than the last.

The amount of active inhibitor present during vegetable decomposition is always extremely small and follows closely the concentration of the reservoir of unchanged 'Schradan'. Were the observed inhibitions due to the much more toxic compound tetraethyl pyrophosphate, they are so small that they would be considered to be quite without toxic significance. The susceptible animal converts 'Schradan' to an inhibitor far more rapidly than the plant, and therefore the transient inhibitor attains much higher concentrations. It is therefore quite without importance whether a very small amount of conversion has previously occurred within the plant.

Dr. Hartley described some of the more recent work done by Dr. Heath and collaborators, which has unearthed a rather more stable vegetable derivative of 'Schradan' that is not itself an activator. The generally accepted view is that the active derivative has an amide oxide structure. The less active and more stable derivative has probably a hydroxymethyl group. He felt that the decomposition of 'Schradan' inside the plant has now been sufficiently explored to meet any reasonable doubts about the safety of this compound. Questions are still being asked as to whether the plant might not resynthesize some quite new toxic substance from the original insecticide, but he pointed out that there are many naturally toxic compounds in food crops, and an equal anxiety should really arise, therefore, with regard to the activities of the plant breeder and the applicant of fertilizers.

Dr. P. R. Carter, of Albright and Wilson, Ltd., gave a detailed account of the application of measurements of differential hydrolysis-rate to the analysis of mixtures of organo-phosphorus compounds.

Mr. J. F. Newman, of Imperial Chemical Industries, Ltd., then dealt with the technique of bioassay of the organo-phosphorus compounds. He said that chemical methods are always to be preferred for precise determination in cases where there is no doubt about the compound to be determined; but in many cases one does not know the full story about the chemical composition in relation to toxic effect, either because the original compounds are associated with active impurity, or because there may have been some conversion as a result of biochemical or weathering attack after application. Biological assay has therefore a necessary part to play, and it is also in the majority of cases capable of greater sensitivity, although of less accuracy than chemical methods. Mr. Newman described various devices for rendering biological assay methods more reproducible, and dealt with the importance of choosing the most suitable measure of intoxication, which is very rarely death itself. He said that he prefers, where possible, to use aquatic species, such as mosquito larvæ or daphnia, so that the toxic substance can be presented in a uniform environment.

There was general agreement with Mr. Newman's thesis that bioassay methods are absolutely necessary in many cases, although never so precise as chemical methods, and Mr. A. L. Bacharach pointed out that the development of pharmaceutical science owes a very great deal to the alternate use and comparison of biological and chemical methods of estimation.

Dr. Edson made a plea for a bolder approach on the part of the medical profession to the problem of permissible residues of toxic materials. The reluctance of medical workers to commit themselves as to what can be permitted as safe is doubtless due to the inherent difficulty of proving a negative. It is so much easier to prove that a large amount is dangerous than to prove that a small amount is safe; but he felt that the importance of the practical problem demands that people should be bold enough to make decisions, even at the risk of their being proved wrong by later generations. Dr. R. A. E. Galley supported this very realistic attitude, and quoted a remark of a distinguished contributor to this subject, that there is more danger of men's minds being poisoned against the use of insecticides than there is of their bodies being poisoned by the insecticides themselves.

G. S. Hartley

BRIGHTON AND HOVE NATURAL HISTORY SOCIETY

CENTENARY SESSION

The Brighton and Hove Natural History Society will attain its centenary during the present session, which opened on October 10 with a review of the past hundred years by the general secretary, Mr. F. Edwards, followed by a conversazione.

The exact date of the founding of the Society is not known with certainty; but it was no doubt a natural development of some of the existing societies such as the Royal Literary Society. The proceedings at the early meetings, with the discussion thereon, were recorded in manuscript and consisted of papers by members; specimens of plants, fossils, etc., were often exhibited. An annual excursion to some place of interest was a regular feature which survived many years, and the earlier excursions were followed by a paper by the secretary, or other member, describing the features of interest observed, often including local legends and ancient history; sketches by a member have been preserved in a portfolio.

During the early period the papers read were all due to the members themselves, and, although later on non-members were invited to give addresses, it is only of recent years that the greater number of papers have been given by non-members. Summaries of the papers were given in the annual reports, and from about 1873 many of them were printed in full. In those days, also, the local newspapers often printed the transactions at the meetings in full, a contrast to the present day when a mention of the meetings is a rare occurrence.

The principal function of a society of this nature is the mutual exchange of scientific knowledge between the members themselves; but its activities should go beyond this, and it is expected that it should either make contributions to science by original investigations by members, or should

increase the spread of knowledge by giving lectures to the general public. The Society's *Proceedings* include many papers in which details of local natural history, archæology, etc., are recorded, but there is little of investigations involving team-work. At various times the Society has sponsored public lectures, and at one time put up a guarantee for a series of lectures by well-known speakers; owing to want of support, the scheme was abandoned. From its inception the Society was active in forming a library of the standard scientific works of the time and also in collecting the *Proceedings* of learned societies and other natural history societies, and for a long while these books have been in the charge of the Brighton Corporation librarian.

For many years the Society has sent delegates to the meetings of the British Association for the Advancement of Science and of the South-Eastern Union of Scientific Societies, and when either of these bodies has met in Brighton the Society has undertaken the organizing of conversaziones, excursions, etc. Thus, at the British Association meeting at Brighton in 1872, no less than fifty microscopes were assembled at a conversazione, and a contribution was made to the Sub-Wealden boring at Netherfield, near Battle, which was undertaken in preparation for the meeting. More recently the Society has participated in the activities of the meeting of the British Association in 1948 and of the South-Eastern Union in 1947.

At various times sections were formed to cater for the special interests of members in various fields, and at one time up to seven were in being; but the only section which has had a more-or-less continuous existence is the Microscopical Section, which was first set up formally in 1870 and at the present time is one of the principal features of the Society.

The active life of a scientific society is principally due to a small number of members who keep things going, and the Brighton and Hove Natural History Society is no exception. The survival from the time a hundred years ago to the present day is largely due to two of the earliest secretaries, T. W. Wonfor, who held office during 1855–78, and E. A. Pankhurst, who reorganized the Society in 1886 and held office for sixteen years, before becoming president himself.

SOOTY BARK DISEASE OF THE SYCAMORE

AHITHERTO unreported fungus, *Cryptostroma corticale*, was noted on a dead sycamore in Wanstead Park, London, in 1945. Three years later, Mr. S. Walker had located about forty dead or dying sycamores in the Park, all of them infected with the same fungus, and it thus became obvious that a hitherto undescribed disease was active in the neighbourhood. The investigations carried out are detailed in Forestry Commission Leaflet No. 30 under the title "Sooty Bark Disease of Sycamore, *Cryptostroma corticale*"*.

It is now known that the fungus has a wider distribution. Up to July 1952 the fungus had been found south of London as far as Croydon and south-west as far as Guildford. To the west it has been recorded at Henley, while to the north-east it has been noted as far away as Mundford near Thetford in Norfolk. It has not been found outside the suburbs to the east and south-east of London. The information is based on partial survey only. In the London area the fungus is very generally distributed in parks and cemeteries but, so far, has only occurred on a large scale in Wanstead Park and a few neighbouring areas. One interesting point for further investigation is that whereas in Wanstead Park, and generally elsewhere in the London area, the fungus appears to be acting as a virulent parasite, in other areas, including all the occurrences outside London, the fungus is growing only on trees probably killed, or at any rate weakened, by other agencies. The effect of the fungus on the tree varies enormously. In some cases where it occurs it appears to behave as a severe parasite, killing trees of all sizes with considerable rapidity; but in other cases the effect may be relatively slight, attack being restricted to trees or branches of trees killed or damaged by other agencies. More requires to be known; but the disease constitutes a definite threat.

The organism believed to cause the disease forms hard black layers which separate, leaving shallow chambers in the tissue of the bark. The floor and roof of these cavities are kept apart by black columns up to 1 mm. long by 0·3 mm. in diameter, which usually persist after the shedding of the outer bark. The roof layer and the outer bark are eventually shed, exposing the spore mass, which forms a bluish-grey layer on top of the black floor layer. The tiny spores appear brownish-black in the mass and have a sooty appearance—hence the name of the disease. The first obvious sign of attack is often a blistering of the bark, which peels off, exposing the soot-like mass. Trees affected seriously should be felled, split up and burnt on the spot if possible; but control and prevention will require further research.

* Forestry Commission. Leaflet No. 30: Sooty Bark Disease of Sycamore, *Cryptostroma corticale*. Pp. 8. (London: H.M.S.O., 1952.) 9d. net.

PRODUCTION OF OXYGEN FROM CHLOROPLAST PREPARATIONS

Photochemical Oxygen Production from Isolated Algal Chloroplast Fragments

SINCE the work of Hill[1] on the photochemical oxygen production by isolated chloroplasts, most of the experiments on this reaction have been done with chloroplasts from leaves. Chloroplast preparations from algæ have shown negligible activity[2].

We have made chloroplast preparations from unicellular algæ by mixing the cells with finely powdered alumina to make a thick paste, and forcing the paste through a fine crack in a steel cylinder under high pressure (details will be published later). The macerate is then taken up in 0·03 *M* phosphate buffer (*p*H 6·7) containing 0·3 *M* sucrose and briefly centrifuged twice at low speeds to remove the alumina and whole cells. The supernatant fluid contains finely divided chloroplast fragments ranging from diameters of about 2 μ down to below the limit of resolution of a light microscope. This fragmented chloroplast suspension, mixed with an oxidant (ferric oxalate–potassium ferricyanide[3] or quinone[4]), shows photochemical oxygen production with activities comparable to those reported for leaf chloroplast

preparations[4]. The suspension of chloroplast fragments may be mixed with oxidant directly, or the fragments may be centrifuged down at high speed and taken up in fresh sucrose–phosphate buffer containing 0·01 *M* potassium chloride[4].

For comparison, we prepared suspensions of chloroplasts from *Phytolacca americana* either by macerating the leaves in a Waring blendor, or by forcing cut pieces of leaves through the pressure cylinder in the same manner as the chloroplast preparations were made from algal cells. The algal chloroplast material evolved oxygen at the same rate as *Phytolacca* plastids.

Oxygen production was measured manometrically with 7 ml. of washed chloroplast fragment suspensions containing a minimum of 0·51 mgm. chlorophyll/ml. in a box-shaped vessel of 13·6 ml. volume. The gas space was flushed with commercial nitrogen. The temperature of the experiment was 15°. The light source was a neon discharge tube with a red filter cutting out wave-lengths shorter than 580 mμ. Measurements with the Warburg–Schocken actinometer[6] indicated a radiation flux of $0{\cdot}14 \times 10^{-6}$ einsteins/min.-cm.^{2} at the position of the manometer vessel. It was necessary to reduce the light intensity with neutral filters to a level at which it can be measured accurately by this actinometer. The illuminated area of the vessel was 7·35 cm.^{2}. The rate of oxygen production, from either algal or *Phytolacca* chloroplast material, was 1·0 μl. oxygen/min., leading to a quantum requirement of 20–25 quanta absorbed per molecule oxygen produced. This yield is in reasonable agreement with corresponding measurements by French and Rabideau[5] and Ehrmantraut and Rabinowitch[7], and greatly exceeds that reported by Warburg[8]. Our results do not indicate that maximum efficiency has been attained, and further work on this aspect of the problem is in progress.

Active chloroplast fragments have been prepared from *Chlorella pyrenoidosa*, Chick (Emerson's strain), *Chlorella vulgaris*, Beyerinck (Pratt's strain), *Bracteococcus* sp. (this organism, also called *Dictyococcus*, was supplied by Dr. Richard Starr, Botany Department, Indiana University); *Scenedesmus obliquus D-3* (Gaffron's strain) is the only organism we have been unable to break in the pressure cylinder. *Anabaena variabilis* (Hecker's strain) breaks very easily in the pressure cylinder, but its grana fragments do not show photochemical oxygen production, either in the whole macerate which contains phycocyanin in solution, or after the fragments have been centrifuged down and resuspended in fresh buffer.

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Active Chloroplast Preparations from *Chlorella pyrenoidosa*

Punnett and Fabiyi point out in the preceding communication that our knowledge of the cell-free photochemical system from green plants has been mainly derived from leaves; recent knowledge of the physiological process of photosynthesis has been mainly derived from the study of unicellular organisms since Warburg[1] introduced the manometric method with cell suspensions. Warburg and Luttgens[2] established the first link between two fields of work by showing that both whole cells of *Chlorella* and the chloroplast preparations from leaves would reduce benzoquinone in light with the production of oxygen. However, quinone was the only known hydrogen acceptor giving a characteristic chloroplast reaction with *Chlorella*. While with the whole cells other hydrogen-accepting reagents gave results which have been interpreted with difficulty[3], quinone, by its lethal action and its apparently ready penetration of the cell wall, gave results equivalent to the cell-free preparations of chloroplasts from leaves. Thus, Punnett and Fabiyi have now provided the first direct method for comparing the activities *in vitro* and *in vivo* of the photochemical system from *Chlorella*—a 'classical' organism in the study of photosynthesis.

One of us (D. H. N.) has been using the Mickle cell disintegrator[4] for the preparation of cell walls from *Chlorella*. The cell walls may be spun off as a white layer; the cell-free supernatant green juice has been found to show reactions similar to the cell-free preparations from leaves of plants. We obtained results with hydrogen-accepting reagents essentially similar to those of Punnett and Fabiyi. The preparations also show the indirect photochemical reduction of methæmoglobin; this indicates the presence of a natural hydrogen-acceptor in *Chlorella* similar to the methæmoglobin-reducing factor found in leaves[5]. When the chlorophyll is removed from the cell-free *Chlorella* preparation with acetone, the cytochrome components are observed to resemble those characteristic of similarly treated chloroplasts from a leaf[6] and those directly observed in etiolated barley plastids[7].

The *Chlorella* cells were washed once with distilled water and transferred to the glass cups of the Mickle cell disintegrator. In each cup (2 cm. dia., 6 cm. long) were placed 5 ml. packed cells, 4 gm. glass beads (Ballotini No. 12, dia. 0·15 mm.) and, after cooling to 4°, cold distilled water to give a final volume of 11·0 ml. The disintegrator was run in a cold room at 4° for one hour and the suspension decanted from the glass beads. The suspension was spun for 5 min. at 1,500 *g* in an angle-head centrifuge. This gave a dark green supernatant and a deposit of three layers: at the bottom unbroken cells, then a mixture of the latter with cell walls and cell contents, and at the top a white layer of broken cell walls. The green supernatant was spun again at 1,500 *g* for a further 5 min. to remove any further solid material and kept at 0° for use in subsequent experiments. Chloroplasts from leaves of the garden pea and methæmoglobin factor from leaves of *Lamium album* were prepared, and activity measured by methods previously described[5]. The photochemical production of oxygen by the chloroplast preparations was measured in Warburg manometers with ferricyanide, using the procedure of Arnon and Whatley[8]. The chlorophyll concentrations in the stock

suspensions were determined by the method of Mackinney[9].

When the dilute green juice of *Chlorella* was exposed to light in the presence of methæmoglobin, no appreciable reduction of the hæmoprotein occurred. The addition of methæmoglobin factor from *Lamium album* resulted in rapid and complete reduction. On centrifuging the green juice at 1,700 *g* for 40 min. the chlorophyll concentration was reduced to a twentieth. Thus twenty times the volume of the centrifuged juice could be added to give the same chlorophyll concentration in the reaction mixture. Under these conditions, methæmoglobin was slowly reduced in the light without the addition of the *Lamium* factor. The activity of these processes was measured in terms of $Q^{chl.}_{O_2}$ (μl. oxygen/hr./mgm. chlorophyll) and compared with the activity of pea chloroplasts (Table 1).

Table 1. Reduction of Methæmoglobin

Total volume, 2·5 ml. $1·6 \times 10^{-4}$ *M* methæmoglobin; 0·033 *M* phosphate buffer *p*H 7; reaction saturated with respect to light and to concentration of added factor. Factor prepared from *L. album*

	Half-time (sec.)	Chlorophyll (mgm.)	$Q^{chl.}_{O_2}$
Pea chloroplasts plus factor	55	0·34	2,100
Pea chloroplasts alone	1,500	0·34	77
Chlorella green juice alone	∞	0·30	zero
Chlorella green juice plus factor	112	0·30	1,170
Spun *Chlorella* juice alone	450	0·30	270

We may thus conclude that the chloroplast preparation from *Chlorella* is reactive with the methæmoglobin-reducing factor obtained from the higher plant. It may also be concluded that *Chlorella* contains a similar soluble methæmoglobin-reducing factor.

In Table 2 a comparison is given with pea chloroplasts in the production of oxygen from ferricyanide determined manometrically. In this case the light was below that required for saturation. The *Chlorella* preparation was found to lose one-half of the activity after 15 min. in the manometer at 15°. The pea chloroplasts preserved their activity and gave after 30 min. a stoichiometric production of oxygen. The production of oxygen was also confirmed by the hæmoglobin method[10] with ferri-oxalate as hydrogen acceptor.

Table 2. Manometric Determination of Oxygen Production

	Initial rate (μl./hr.)	Chlorophyll per vessel (mgm.)	$Q^{chl.}_{O_2}$
Pea	270	0·294	920
Chlorella	140	0·238	590

The cytochrome components were examined with the Zeiss microspectroscope. Diluted green juice, equivalent to 0·4 ml. cells, was treated with 4 vol. acetone in the cold and the mixture filtered off in a Buchner funnel with a paper 4 cm. in diameter. After washing with cold acetone, the paper was allowed to dry, folded twice, moistened with phosphate buffer at *p*H 7 and immediately examined by transmitted light. A sharp absorption band was seen at 554–555 mμ (cytochrome *f* 555 mμ). Treatment with sodium hyposulphite resulted in a band at 563 mμ (cytochrome *b* in leaf chloroplasts 563 mμ), while the band corresponding to cytochrome *f* was unchanged. Carbon monoxide did not affect the bands. Treatment of the preparation with pyridine and sodium hyposulphite produced a strong band mainly of pyridine protohæmochromogen, and this seems principally to be derived from the cytochrome *b*. From the intensity of the spectrum observed, the ratio of cytochrome *f* to chlorophyll would be about 1 : 500, which is similar to that observed in leaves[11]. The band corresponding to cytochrome *f* from *Chlorella* appears to be slightly to the violet side of that from the leaf chloroplasts. This may be due either to the presence of a little cytochrome *c* or to an actual difference in the protein portions of the cytochromes.

It thus seems that certain systems connected with the process of photosynthesis have a wide distribution among types of green plants, as in the case of respiratory systems.

For his stimulating interest in connexion with this work we are grateful to Dr. Robert Emerson. The work is part of a programme supported by the Agricultural Research Council.

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MECHANISM OF THE INCORPORATION OF ADENINE INTO ADENOSINE MONOPHOSPHATE

THAT purines might be incorporated directly into nucleotides, rather than first forming nucleosides that are then phosphorylated, was first suggested by Greenberg's[1] studies on the incorporation of formate into nucleotides. Williams and Buchanan[2] reported that the formation of inosinic acid (that is, hypoxanthine riboside-5-phosphate) by protein fractions from pigeon liver was greatly stimulated by addition of ribose-5-phosphate plus adenosine triphosphate. Goldwasser[3], working in this laboratory, has observed that adenine incubated in the presence of a particle-free pigeon liver extract was incorporated into adenine nucleotides.

In this communication we wish to summarize some new facts which may give the clue to the mechanism of one of the pathways of formation of adenosine monophosphate in animal tissues. Our experiments strongly suggest that adenosine monophosphate is the first nucleotide formed and that the overall reaction, starting from adenosine triphosphate, ribose-5-phosphate, and radioactive adenine, proceeds in two steps which we have been able to separate. The first step, catalysed by a heat-labile enzyme, is :

Ribose-5-phosphate + ATP →
ribose-1,5-diphosphate + ADP.

The second step, catalysed by a relatively heat-stable enzyme, is probably :

Ribose-1,5-diphosphate + adenine →
AMP + phosphate.

We propose that these enzymes be named respectively '5-phosphoribokinase' and 'nucleo*tide* phosphorylase'.

The pigeon liver extract was prepared by homogenizing livers in 10 volumes of a medium consisting of 0·13 *M* potassium chloride ; 0·015 *M* potassium dihydrogen phosphate ; 0·01 *M* magnesium chloride, brought to *p*H 7·2 with potassium hydroxide. The homogenate was spun at 80,000 *g* and the particle-free supernatant was dialysed against the homogenizing medium. The dialysed extract was stored at − 20° and was stable for several weeks. The activity of the extracts was tested by incubating a small volume with 7 γ of 8-carbon-14-adenine (= 7,000 counts per minute). After 30–60 min. at 37° the carbon-14 content of the acid-soluble nucleotides was determined.

The dialysed pigeon liver extract did not incorporate appreciable amounts of carbon-14-adenine into the acid-soluble nucleotides, but the activity could be wholly restored by adding ribose-5-phosphate together with adenosine triphosphate. Either of these substances alone was relatively ineffective. Ribose-5-phosphate could be replaced by ribose-1-phosphate, but ribose-'3'-phosphate, deoxyribose-1-phosphate and ribose had only feeble effects when added with adenosine triphosphate. Adenosine monophosphate and inosinic acid were also ineffective as activators of the extract (Table 1). After separation by paper ionophoresis of the nucleotides formed from carbon-14-adenine, when ribose-5-phosphate and adenosine triphosphate were added, adenosine monophosphate had the highest specific radioactivity (Fig. 1).

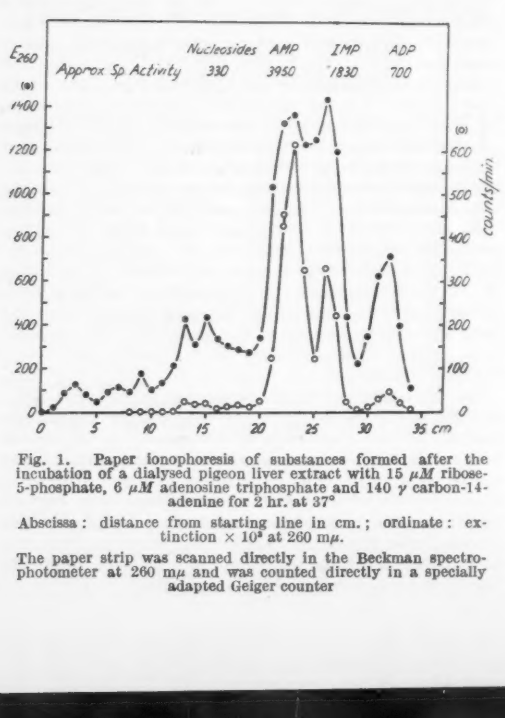

Fig. 1. Paper ionophoresis of substances formed after the incubation of a dialysed pigeon liver extract with 15 μM ribose-5-phosphate, 6 μM adenosine triphosphate and 140 γ carbon-14-adenine for 2 hr. at 37°

Abscissa : distance from starting line in cm. ; ordinate : extinction × 10^3 at 260 mμ.

The paper strip was scanned directly in the Beckman spectrophotometer at 260 mμ and was counted directly in a specially adapted Geiger counter

Table 1. Reactivation of a Dialysed Extract of Pigeon Liver

Additions	Counts/min. in the acid-soluble nucleotides
Undialysed extract, 0·5 ml.	2,150
Dialysed extract, 0·5 ml.	15
+ 3 μM ribose-5-phosphate + 1 μM ATP	1,860
+ 3 μM ribose-5-phosphate	82
+ 1 μM ATP	22
+ 3 μM ribose-1-phosphate + 1 μM ATP	2,250
+ 3 μM ribose-'3'-phosphate + 1 μM ATP	53
+ 5 μM deoxyribose-1-phosphate + 1 μM ATP	30
+ 5 μM ribose + 1 μM ATP	90
+ 1 μM AMP	15
+ 1 μM inosinic acid	15

7 γ = 7,000 counts/min. of 8-carbon-14-adenine added in every case

The undialysed particle-free pigeon liver extract was also stimulated by the addition of ribose-5-phosphate and adenosine triphosphate ; but after heating such an extract at 65° for 5 min. the incorporation of adenine was decreased and could not now be stimulated by the addition of ribose-5-phosphate and adenosine triphosphate (Table 2). This observation suggested that the adenosine triphosphate-dependent enzyme is heat labile, but that the incorporation of adenine still occurs in a heated undialysed extract. That the incorporation of adenine takes place without the participation of adenosine triphosphate rules out the phosphorylation of adenosine[4] as a step in the formation of adenosine monophosphate under these conditions. The heat-lability of the adenosine triphosphate enzyme made it possible to demonstrate that adenosine triphosphate reacts with ribose monophosphate. The dialysed extract was incubated at 37° for 1 hr. with ribose-5-phosphate or ribose-1-phosphate and adenosine triphosphate. The incubation mixture was heated at 65° for 5 min. and the denatured proteins were spun off. Carbon-14-adenine was added to the supernatant. After a further incubation at 37° the nucleotides were analysed for carbon-14. The results (Table 3) clearly indicate that : (1) during the preincubation at 37° the ribose monophosphates reacted with adenosine triphosphate to form a substance from which the heated extract could form radioactive nucleotide with carbon-14-adenine ; (2) the enzyme for the ribose-monophosphate reaction is heat labile ; and (3) the adenine-incorporating enzyme is relatively heat-stable. The purification of the heat-labile enzyme is described in the following communication. After our work was completed, Korn and Buchanan[5] reported that one of the pigeon liver fractions needed for the synthesis of inosinic acid from hypoxanthine is also stable to heating. The heat-stable enzymes that form adenosine

Table 2. Activation of Undialysed Extracts

Additions	Counts/min. in nucleotides: Unheated extract	Heated extract
None	1,519	420
3 μM R-5-P	1,652	483
1 μM ATP	987	182
3 μM R-5-P + 1 μM ATP	2,170	140

Table 3. Preincubation of Ribose Monophosphate with Adenosine Triphosphate

	Counts per min. in nucleotides: R-1-P	R-5-P
1 ml. dialysed extract incubated at 37° for 1 hr. with 3 μM ribose monophosphate and 3 μM ATP. Heated at 65° for 5 min. Added 7 γ ^{14}C-adenine. Further incubation at 37° for ½ hr.	1,161	1,066
1 ml. dialysed extract heated at 65° for 5 min. Incubated with 3 μM ribose monophosphate, 3 μM ATP and 7 γ ^{14}C-adenine for ½ hr. at 37°	0	0

monophosphate and inosinic acid may possibly be identical.

To support the supposition that ribose-1,5-diphosphate is an intermediate in the formation of adenosine monophosphate from adenine, ribose-1,5-diphosphate was prepared by the reaction of Klenow and Larsen[6]:

Glucose-1,6-diphosphate + ribose-1-phosphate ⇌
ribose-1,5-diphosphate + glucose-6-phosphate

and was used as an activator of the dialysed medium (Table 4).

Table 4. INCORPORATION OF CARBON-14-ADENINE USING RIBOSE-1,5-DIPHOSPHATE FORMED FROM GLUCOSE-1,6-DIPHOSPHATE* AND RIBOSE MONOPHOSPHATE

μM Ribose-1,5-diphosphate added	Counts/min. in nucleotides
0·30	1,840
0·10	1,250
0·027	1,110
0·009	746

* Synthetic α-glucose-1,6-diphosphate was a gift from Prof. T. Posternak, of Basel.

We wish to acknowledge with thanks the interest shown in this work by Dr. H. M. Kalckar.

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A New Phosphokinase, 5-Phosphoribokinase

DURING an investigation of the enzymatic synthesis of adenosine monophosphate (see preceding communication) the existence of a phosphoribokinase was recognized. This communication outlines a partial purification of an enzyme from pigeon liver which catalyses the following reaction:

Ribose-5-phosphate + ATP →
ribose-1,5-diphosphate + ADP.

By analogy with the other phosphokinases we propose to call this enzyme '5-phosphoribokinase'.

The enzyme is assayed spectrophotometrically in the presence of an excess of 5-adenylate-kinase and 5-adenylate-deaminase, following the decrease in optical density at 265 mμ due to the deamination of adenosine monophosphate[1].

The reactions involved are:

2 ribose-5-phosphate + 2 ATP →
2 ribose-1,5-diphosphate + 2 ADP
2 ADP → ATP + AMP
AMP → IMP + NH_3

2 ribose-5-phosphate + ATP →
2 ribose-1,5-diphosphate + IMP + NH_3

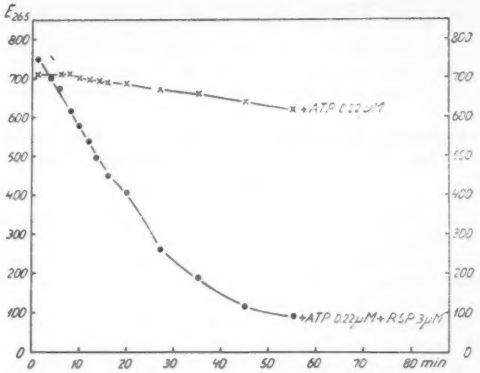

Fig. 1. The reference cuvette contained 0·22 μM adenosine triphosphate in 3 ml. and the spectrophotometer was brought to zero at an optical density of 0·5. The experimental cuvettes contained 0·39 mM potassium chloride, 0·03 mM magnesium chloride, 0·045 mM dipotassium hydrogen phosphate, 5-adenylate kinase 20 γ of protein per ml., 5-adenylate deaminase 25 γ of protein per ml., total volume 3·19 ml., pH 6·8. At time 0, 110 γ of protein per ml. of 5-phosphoribokinase was added to the experimental cuvettes
Abscissa: time in minutes; ordinate: extinction × 10^3 at 265 mμ

Fig. 1 gives the results of an experiment which shows that without the addition of ribose-5-phosphate there is practically no dephosphorylation of adenosine triphosphate. From the graph it is evident that the reaction stops when both energy-rich phosphate groups of adenosine triphosphate are used up.

The ribose-1,5-diphosphate formed can be isolated on a 'Dowex-1' formate column following the procedure of Klenow[2].

Preparation of the enzyme from pigeon liver involves the following steps: (1) homogenization of the tissue in 0·26 M potassium chloride, 0·02 M dipotassium hydrogen phosphate, 0·001 M magnesium chloride, pH 8. (2) Centrifugation at 30,000 g in the Spinco ultracentrifuge for half an hour. (3) Ammonium sulphate fractionation of the supernatant between 0·35 and 0·52 saturation in 0·01 M magnesium chloride at pH 8·5. (4) The precipitate is dissolved in 0·13 M potassium chloride, 0·01 M magnesium chloride, 0·0001 M glutathione, 0·015 M *tris*-hydroxymethyl aminomethane, pH 8, and frozen at − 20°. The next day the solution is thawed, and denatured protein is spun off. With this procedure a 12-fold purification is achieved.

The enzyme is inactivated by dialysis against the dissolving medium for 18 hr. at 4°.

This preparation of 5-phosphoribokinase has no action on D(−)ribose, ribose-1-phosphate, ribose-'3'-phosphate, D(+)glucose, glucose-1-phosphate, glucose-6-phosphate and D(+)galactose, but contains considerable 6-phosphofructokinase activity.

I am indebted to Dr. H. M. Kalckar for his encouragement and interest.

These studies were supported by grants from Carlsbergfondet, Rockefeller Foundation, Lederle Laboratories Division of the American Cyanamid Co., Istituto Sieroterapico Italiano and the Life Insurance Medical Research Foundation.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Determination of the Structure Factor of Thin Tin Films from Superconductivity Measurements

In a recent communication[1] on superconductivity of thin tin films, we mentioned the difference we found between the values for the magnetic threshold, the external field being parallel ($H^c_{\parallel}$) or perpendicular ($H^c_{\perp}$) to the support of the film (in both cases perpendicular to the direction of the current). We mostly use flattened strips of 'Pyrex' to support the films. Zavaritskiĭ[2] has also found a difference between $H^c_{\parallel}$ and $H^c_{\perp}$.

Our films are prepared by condensation in vacuum or by sputtering in argon gas. As we remarked earlier[1], a very pronounced change is obtained for the form of the transition curve (R/R_0 as a function of an external field H) when the current increases. The transition curve becomes very sharp. We have now determined for different films, condensed or sputtered, the magnetic threshold values for $H_{\parallel}$ and $H_{\perp}$ for different values of the current and also as a function of temperature.

Table 1

Date	$R(\Omega)$ at 290° K.	$R(\Omega)$ at 4·2° K.	T (° K.)	Current	$H^c_{\parallel}$ (Oersted)	$H^c_{\perp}$ (Oersted)	$H^c_{\parallel}/H^c_{\perp}$
March 6, 1953	160	53·2	3·64	50 μA.	320	240	1·33
			3·03	50 μA.	1,650	880	1·87
				5 mA.	980	520	1·88
			2·28	50 μA.	2,580	1,490	1·73
				5 mA.	1,900	1,050	1·81
			1·86	50 μA.	2,920	1,860	1·57
				2 mA.	2,560	1,620	1·58
				5 mA.	2,340	1,480	1·58
				10 mA.	2,140	1,380	1·55
March 13, 1953	—	53·2	2·94	10 μA.	1,390	1,020	1·36
				2 mA.	1,240	860	1·44
				5 mA.	920	590	1·56
				10 mA.	530	360	1·47
			2·26	10 μA.	2,500	1,610	1·55
				2 mA.	2,090	1,400	1·49
				5 mA.	1,690	1,140	1·48
				10 mA.	1,220	830	1·47
March 20, 1953	—	67·0	2·41	50 μA.	3,000	1,815	1·65
				2 mA.	2,550	1,440	1·78
				5 mA.	2,130	1,210	1·76
				10 mA.	1,395	850	1·64

In Table 1 are some results obtained with one of our condensed films in vacuum. This film has been measured three times on different dates, with the view of examining its behaviour; for certainly a change in the crystallization has occurred. After the second series of measurements the film was brought into contact with the air, so that an oxidation took place.

From the table we drew the following conclusions: (1) The ratio $H^c_{\parallel}/H^c_{\perp}$ is approximately constant as a function of current and temperature. Its value is between 1·5 and 1·8. Deviations occur near the transition temperature; but this seems to be due to errors in determining H^c. A small increase only is observed for the second series of measurements. (2) There is only a small variation of the ratio $H^c_{\parallel}/H^c_{\perp}$ in the different series of measurements in spite of the fact that the specimens have undergone several manipulations.

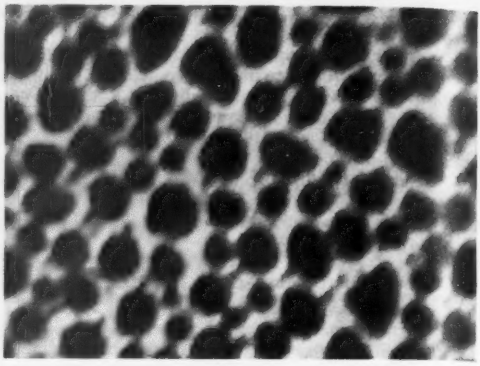

Fig. 1

For our sputtered films, we obtained for $H^c_{\parallel}/H^c_{\perp}$, as for our condensed films, constant values as a function of current, but which are larger. Thus we found $H^c_{\parallel}/H^c_{\perp} = 2$ in most cases, but in other cases a value of 5 was obtained.

The different results obtained can be explained by means of the demagnetizing factor. If we suppose that the layers are composed of flat ideal superconducting ellipsoids, we have $H^c_{\parallel}/H^c_{\perp} = 1/(1 - D)$ with $D = N/4\pi$. Thus we found for our condensed films $D = 0{\cdot}66$ and for our sputtered films $D = 0{\cdot}5$ and $D = 0{\cdot}8$ respectively, which correspond to a ratio m of the axes of 0·3, 0·5 and 0·15 (ref. 3).

On the other hand, pictures were taken of sputtered films (see Fig. 1) in our laboratory, for an earlier publication[4], by means of the electron microscope. From this picture the equatorial axes of the ellipsoidal grains can be determined; knowing, however, the ratio m from the magnetic measurements the thickness of the grains can be estimated. Thus we have been able to estimate the thickness of the grains shown in Fig. 1. For the largest grains (diameter 120 mμ), we obtained a thickness of 36 mμ, and for the thinnest one 7·5 mμ (diameter 25 mμ). This seems to be a reasonable thickness, taking into account the value of the resistance. But we may remark that the thickness seems to vary between wide limits.

We wish to thank the Department of Education, Brussels, for financial aid for this investigation.

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Specific Ionization produced by Positrons and Electrons

ALTHOUGH ionization produced by an electron in its passage through various gases has been studied by previous workers[1], to our knowledge no experiment has been performed with the positron which will enable the specific ionization produced by a positron and an electron of the same energy to be compared. In the present experiment, this has been done by investigating the specific ionization by positrons and electrons in nitrogen and argon, using a fully automatic Wilson chamber. Rhodium-102 prepared by bombarding rhodium-103 by fast neutrons was used as the source.

The accompanying table gives the number and length of the tracks studied.

Element	No. of tracks		Length of tracks (cm.)	
	Positron	Electron	Positron	Electron
Nitrogen	174	263	1,652·9	3,183·2
Argon	187	282	2,169·2	3,257·6

Only those positrons and electrons the energy of which lies between 0·18 MeV. and 0·96 MeV. were taken into account.

Figs. 1 and 2 show the variation with H_ρ of specific ionization in nitrogen and argon, respectively, where H is the magnetic field and ρ is the radius of curvature of the track. In the case of nitrogen, the theoretical curve as calculated from the formula of Williams[2], having regard only to the 2*p*-electrons, is also given. The ionization potential of the 2*p*-electron for nitrogen in the molecular state is not known; consequently, we have taken the value for the atomic state, which is 15·5 eV. It can be seen from Fig. 1 that, within experimental error, there is no difference between the specific ionization produced by positrons and that by electrons, and also that the agreement between the theory and experimental results is satisfactory. According to Fig. 2, however, it appears that the specific ionization in argon by positrons is somewhat less than by electrons. It should be noted that at higher energies, where the accuracy of measurement is greater, the divergence between the two values nearly disappears. The difference is noticeable towards the lower energies where the higher concentration of ions along the tracks makes counting them an extremely tedious task, with the result that the subjective error is greater, as it is difficult to resolve two closely spaced ions. For this reason it is not possible to say with certainty whether the difference observed in argon between the positrons and electrons is real. The ideal conditions in which to study this effect would be by employing a low-pressure cloud chamber where greater accuracy in counting the number of ions could be achieved because of the smaller density of ions along the track.

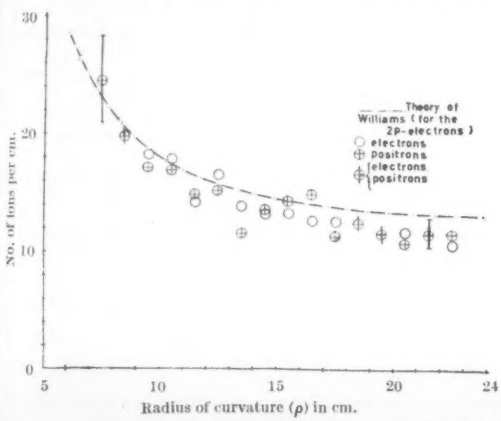

Fig. 1. Variation of primary specific ionization produced by positrons and electrons in nitrogen. $H_\rho = 204 \times \rho$ gauss-cm.

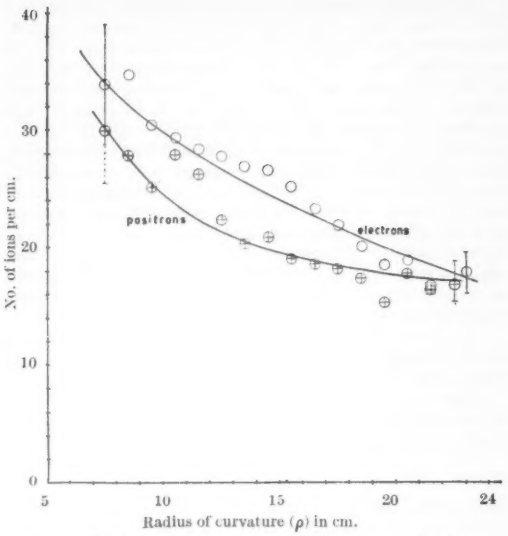

Fig. 2. Variation of primary specific ionization produced by positrons and electrons in argon. $H_\rho = 204 \times \rho$ gauss-cm.

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Recombination Coefficient in the *F*-Regions: a Possible New Process of Ionization of Nitrogen Molecules

IT is now generally recognized[1,2] that the high day-time rate of disappearance of electrons in the *E*- and *F*-regions of the ionosphere cannot be fully explained by the negative-ion formation theory of Bates and Massey[3], which takes account of the electron loss mainly due to attachment. The high value of the recombination coefficient in the *E*-region and in the upper parts of the *D*-region has recently been explained by A. P. Mitra and Jones[4] on the basis of dissociative recombination of electrons with O_2^+ and NO^+ ions, which are believed to be the principal ionized constituents at the heights of these regions. It may therefore be inquired if the process of dissociative recombination may not also be operative in the high *F*-regions (F_1 and F_2) and be the determining factor for the disappearance of electrons.

The ionized constituent in the *F*-regions is the O^+ ion. Hence, in order that dissociative recombination may be operative, the atomic ions must give rise to molecular ions. Now, the atmospheric constituents in the *F*-region are nitrogen molecules and oxygen atoms. Therefore, the formation of molecular ions is possible either by transfer of the charge of O^+ to the nitrogen molecule or by the O^+ ion associating itself radiatively with a neutral oxygen atom giving rise to an ionized O_2^+ molecule. The transference of charge from O^+ to the nitrogen molecule in the ground state is, however, forbidden, since the ionization potential of molecular nitrogen is greater than that of the oxygen atom. Also the process of radiative association is found to be too slow to explain the daytime recombination coefficient of the *F*-layers.

However, if one recalls that during daylight hours a considerable percentage of nitrogen molecules may be in the excited $A^3\Sigma_u$ state corresponding to the upper level of the Vegard–Kaplan bands, then a possibility of charge transfer suggests itself according to the reaction :

$$O^+ + N_2\ (A^3\Sigma_u) \rightarrow N_2^+ + O(^1S).$$

Here, the charge transfer is assumed to produce a N_2^+ ion in the ground-state, leaving the neutral oxygen atom in the metastable ^1S state.

Now, as the ionization potential of O is 13·55 eV. and the energy of the $O(^1S)$ state is 4·17 eV., an amount of energy 9·38 eV. is released. This energy is sufficient to ionize the nitrogen molecule in the $A^3\Sigma_u$ state (6·14 eV.), since the ionization potential of N_2 is 15·51 eV. Further, as there is almost exact energy balance, the reaction is highly probable. According to Bates and Massey[1], a resonance process of this nature may have a transfer coefficient of 10^{-11}. If we assume such a value of the coefficient, the concentration of excited nitrogen molecules required to explain the recombination coefficient in the F_2-layer (where the concentration of nitrogen molecules is 5×10^8) is 10^7. Thus, only 2 per cent of the molecules need be excited. Such a percentage is not improbable considering that the intensity of solar radiation in the band of wave-lengths (blue) causing excitation of the nitrogen molecules is very high.

It may be noted that the above process is operative only during the day-time, that is, as long as the concentration of excited nitrogen molecules is large. The contribution of dissociative recombination to the rate of disappearance of electrons falls to a low value in the hours of darkness. However, at night the absence of photodetachment increases the negative ion concentration, and this explains the night-time value of the recombination coefficient by the negative-ion theory alone.

The process discussed above shows how solar radiation in the visible range of wave-lengths may be instrumental in ionizing nitrogen molecules if positively charged particles are present. Incidentally, the process also explains the concentration of N_2^+ ions that is necessary to explain the twilight flash of the first negative bands of N_2^+, according to Wulf and Deming's hypothesis[5].

I am indebted to Prof. S. K. Mitra, under whose guidance the work reported above was carried out. I also wish to thank Mr. S. S. Baral for helpful discussions.

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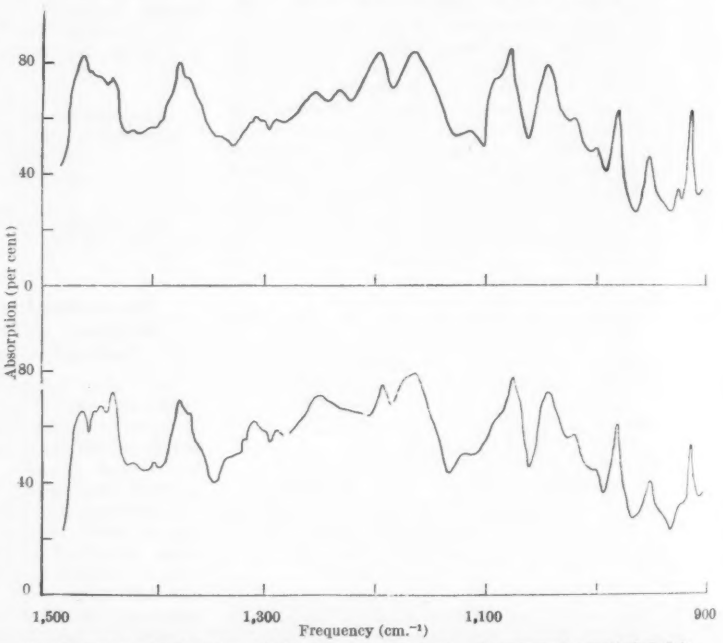
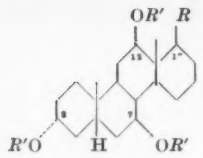
Specificity of Infra-Red Spectra

We have recently examined the infra-red spectra (in carbon disulphide and carbon tetrachloride solutions) of a number of compounds of the general type (I), namely, 3α : 7α : 12α-trihydroxy steroids of the 5β (*A* : *B cis*) series with various groups *R* at C_{17}.



Upper graph : methyl 3α : 7α : 12α-trihydroxycoprostanate. Lower graph : methyl cholate

Fig. 1. Infra-red spectra of methyl 3α : 7α : 12α-trihydroxycoprostanate and methyl cholate from 1,500 to 900 cm.$^{-1}$. The compounds were dissolved in carbon tetrachloride for the region 1,500–1,200 cm.$^{-1}$ and in carbon disulphide for the remainder



(I)

A. R = $-CHMe.[CH_2]_3.CO_2Me$, R' = H

B. R = $-CHMe.[CH_2]_3.CHMe.CO_2Me$, R' = H

C. R = $-CHMe.[CH_2]_2.CH(O)CMe.CH_2OAc$, R' = Ac

Most of the compounds were esters of bile acids; but some related carbinols have also been examined.

The important finding is that all the spectra so far examined are closely similar in the region 1,500–900 cm.$^{-1}$. Fig. 1 illustrates this, comparing the spectrum of methyl cholate (I*A*) with that of methyl 3α : 7α : 12α-trihydroxycoprostanate (I*B*) [1].

The same family likeness is observed in the spectra of the acetyl derivatives, including substances as different as scymnol tetraacetate (I*C*) and methyl triacetylcholate (I, R as in I*A*, R' = Ac).

Although the infra-red spectrum of a compound in the region of the 'molecular fingerprint' (1,200–900 cm.$^{-1}$) has been accepted as providing an unequivocal identification[2], examples of two compounds with very similar spectra have been recorded among the sterols[3] and the triterpenoids[4]. The finding that a whole class of compounds possess virtually the same fingerprint spectrum must modify these views, since a confident identification is impossible when, for example, an isolated compound is not highly purified. The small differences which exist are mainly in the 1,500–1,350 cm.$^{-1}$ region; this region is characteristic of CH_2 and CH_3 bending vibrations to which the side-chain makes a large contribution. In favourable circumstances, it may prove possible to identify the side-chain from the spectrum.

It is expected that similar group resemblances will be shown by the spectra of compounds related to other bile acids, for example, by 3α : 7α-dihydroxy steroids related to chenodeoxycholic acid. If this is the case, it may help in establishing the constitution of new compounds which are related to known steroids.

My thanks are due to Prof. G. A. D. Haslewood and Dr. R. J. Bridgewater for kindly providing compounds.

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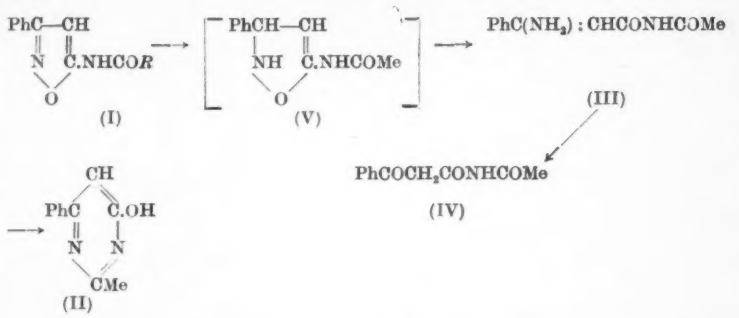
A New Synthesis of Pyrimidines

It has been observed that the hydrogenation of 3-phenyl-5-acetamido*iso*oxazole (I; R = Me)[1] in ethanol using platinum or Raney nickel catalysts gives rise to a mixture of 2-methyl-4-phenyl-6-hydroxy pyrimidine (II) and *N*(β-aminocinnamoyl) acetamide (III), melting point 136°. When the latter compound (readily hydrolysed by cold dilute acid to (IV), melting point 105°) was melted, or when its aqueous solution was warmed, a facile cyclization to (II) occurred; taking this reaction into account, the final yield of the pyrimidine is almost quantitative. An intermediate in the hydrogenation may be the *iso*oxazolin (V), by analogy with the products of hydrogenation of *iso*oxazolones[2]. A similar series of compounds was obtained from (I; R = Ph).

The ready cyclization (III → II) provides an attractive basis for the biogenesis of the pyrimidine structure from the small metabolic units suggested from biochemical studies with isotopically labelled precursors[3], namely, a β-keto acid (or derivative), ammonia and a simple carboxylic acid.



(I) (V) (III) (IV) (II)

A full account of this work and of similar reactions which are still being investigated will be reported elsewhere.

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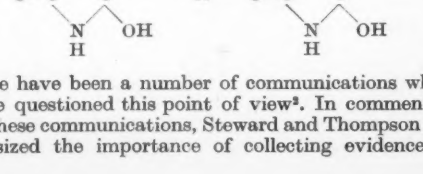
Contribution of the Ultra-Violet Absorption Spectrum of Asparagine to the Problem of its Structure

Since Steward and Thompson first proposed their new cyclic structure for asparagine indicated in the formulæ[1],



there have been a number of communications which have questioned this point of view[2]. In commenting on these communications, Steward and Thompson emphasized the importance of collecting evidence on

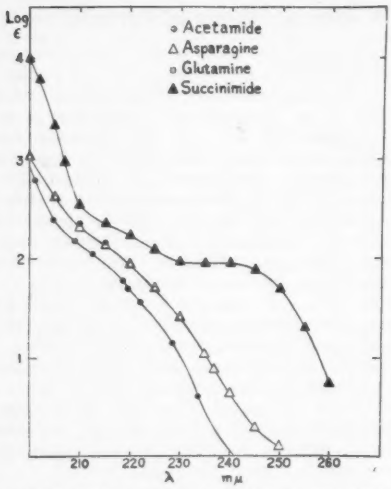


Fig. 1. Spectra of asparagine, glutamine and succinimide were obtained with a Beckman *DU* spectrophotometer using quartz vessels of 1 cm. depth and techniques discussed elsewhere (ref. 4). The acetamide spectrum was obtained by Ley and Arends (ref. 6)

solutions of free asparagine, since it is possible that crystalline asparagine and derivatives of asparagine may not conform to the cyclic structure[3].

No reference appears to have been made to the ultra-violet absorption spectra of water solutions of free asparagine and free glutamine[4]. In Fig. 1, the absorption curves are replotted as log ε versus wave-length (where ε is the molar absorptivity or molar extinction coefficient). The asparagine curve has been extended to longer wave-lengths, and absorption curves for water solutions of acetamide and succinimide have been included in the graph for comparison.

As part of a general study on peptide spectra, a number of unsubstituted and substituted amides have been examined. The detailed results will be presented elsewhere, but for the purposes of this communication it is sufficient to indicate that all the unsubstituted amides examined have the typical inflexion point at about 210 mμ exhibited by asparagine and glutamine. The long-wave-length band at about 240 mμ in the spectrum of succinimide is typical of diacylimides[5]. There is no indication of this band in the asparagine spectrum.

It might well be argued that hydration of one of the carbonyl groups of amino-succinimide would abolish the long-wave-length band to be expected of this compound; but it is difficult to understand how the proposed form of amide could fail to exhibit a spectrum quite different from the typical amide spectrum. One must conclude, therefore, that this evidence favours the straight-chain rather than the cyclic structure of asparagine.

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New Specific Reagent for Keto-Sugars

During an investigation into factors which affect the reaction between sugars and anthrone[1], it was found that anthrone could, under certain conditions, be used as a specific reagent for keto-sugars and is suitable for identification of ketoses on paper chromatograms and in spot tests.

For hexose estimation the anthrone reagent is most effective in solution strongly acidified with sulphuric acid, when green-coloured sugar–anthrone complexes develop with both aldo- and keto-sugars. It was believed that if a condition could be attained in which keto-sugars would be affected preferentially to aldo-sugars, then only the former would afterwards react with anthrone. This condition is realized in a mildly acid medium, where a mixture of acetic acid and ethanol is used as a solvent for anthrone, and phosphoric acid is added to facilitate the required formation of ketose–anthrone complexes.

The reagent is prepared by dissolving 300 mgm. of anthrone (laboratory reagent, B.D.H.) in 10 ml. of glacial acetic acid, by warming, followed by the addition of 20 ml. of ethanol, 3 ml. of phosphoric acid (spec. grav. 1·60 at 20° C.) and 1 ml. of water. Freshly prepared reagent is to be preferred, although if it is kept in the refrigerator it can be used when several weeks old. On standing, crystals may separate out, but these are dissolved on warming the reagent.

For identification of sugars, the reagent is sprayed on a paper chromatogram or a paper treated with test solution. On heating at 108° C. for 5–6 min., mono-, di-, tri- and poly-saccharides containing keto-hexoses develop a bright yellow spot in white light. The keto-pentose (keto-xylose) available for testing gives a bright purple colour, whereas the two available keto-heptoses (D-glucoheptulose and D-manno-heptulose) give an orange-yellow. The developed colours do not fade easily and do not wash off with hot water; washed and dried chromatograms keep well. Under ultra-violet light, the keto-complexes appear brown, while the treated aldoses may show a light blue fluorescence.

The reagent appears to be specific for keto-sugars, and both furanose and pyranose structures in keto-hexoses give a positive test. Thus a strong reaction has been obtained with fructose, fructose-6-phosphate, sorbose, sucrose, turanose, melezitose, raffinose and inulin in addition to the keto-pentose and keto-heptoses mentioned above. No reaction was observed with the aldo-sugars, for example, arabinose, rhamnose, ribose, xylose, galactose, glucose, mannose, cellobiose, lactose, trehalose and dextrin. Sugar alcohols such as mannitol and sorbitol, and sugar acids, including galacturonic and glucuronic acids, do not give a colour reaction, nor do such compounds as inositol, ascorbic, α-ketoglutaric and uric acids; urea gives a grey-coloured spot, which is not likely to be confused with a sugar reaction colour.

For sugars consisting of hexose units, the colour intensity of the spots developed appears to be independent of the sugar itself, and depends only on the molecular concentration of keto-hexose units. Thus the depth of colour produced by 50 mgm. of sorbose, 50 mgm. fructose, 95 mgm. sucrose or 140 mgm. raffinose appears identical. This permits some quantitative estimation of the keto units present. The reaction is sensitive, 5 μgm. of mono-ketose being sufficient for identification.

Keto-xylose was prepared for this investigation from aldo-xylose by a method similar to that described by Hassid *et al.*[2].

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Plastic Sulphur

Liquid sulphur is well known to become highly viscous when heated above 160° C.; this viscous sulphur (like selenium) is easily supercooled. At room temperature the product resembles unvulcanized rubber and is called 'plastic sulphur'. This hardens at liquid air temperature to a brittle glass, vitreous sulphur. At this temperature it remains amorphous for an indefinite time; at room temperature, however, the plastic sulphur crystallizes within a few hours, the crystallization proceeding (as with selenium) from the outside to the inside. We have found that impurities and other factors have some curious effects.

The property of supercooling is completely destroyed by heating the viscous sulphur in a vacuum. The freshly vacuum-baked or vacuum-distilled viscous sulphur crystallizes within a few minutes, when poured into water or liquid air. Older preparations preserved in a vacuum by sealing them off in glass bulbs do the same. The admission of air to the hot preparations spoils them in the long run, but not immediately.

A second fact is that, conversely, the addition of as little as 1 per cent of a trivalent element (phosphorus or arsenic) greatly facilitates the supercooling, the doped mass eventually staying amorphous for at least some months at room temperature. Daylight has no influence on this stability; the exclusion of air, though not necessary, is favourable.

This influence of trivalent elements suggests that the usual supercooling is connected with the presence of some nitrogen in the preparation. The elimination of this nitrogen by vacuum-heating would explain why vacuum-heating of viscous sulphur prevents supercooling.

All the facts known to us may be explained by assuming in viscous sulphur the presence of very long chains, S_∞, instead of the S_8-rings that are known to be stable at lower temperature, probably also in the liquid state below 160°. The long chains are presumably knitted together by the trivalent elements to form a network, more stable than the separate chains would be (compare the vulcanization of rubber).

The conception of long chains being built up above 160° also offers an explanation for the fact that traces of monovalent elements (1 per cent of bromine) greatly reduce the increase of viscosity at 160°, connected with their growth. We may suppose the halogen atoms to react with the terminal valencies of the chains at a rather early stage of their growth, thus stopping further growth until full length is attained. Such inhibition is well known in the production of linear polymers.

The assumption that polymerization occurs at 160°, and that this polymerization is linear, is difficult to prove by direct means. X-ray evidence is inconclusive, because of its insensitivity to minor changes in molecular arrangement in the liquid state. The indirect evidence offered above and by other authors, however, is strong. Moreover, the theoretically well-founded divalence of sulphur makes long chains (scarcely distinguishable from big rings) the most probable molecular shape for explaining the phenomena.

This investigation has been subsidized by the Dutch organization for fundamental research, F.O.M. It has, of course, many points in common with older or simultaneous investigations by others. References can be given only partially here[1].

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Effects of Commercial and Radiation-produced Hydrogen Peroxide

Radiobiologists and radiation chemists have for many years been aware of the fact that hydrogen peroxide formed during irradiation may play a significant part as an agent of the changes brought about by ionizing radiations. The method of checking has often been to expose the test material to concentrations of hydrogen peroxide comparable with those produced by radiation, and hence to deduce what part of the radiation effects must be ascribed to other agents. However, such experiments may be misleading if commercial hydrogen peroxide is used, since the stabilizer which is usually present may inhibit the decomposition of hydrogen peroxide into the intermediates which take part in the particular reactions being studied. Information is not always made available by manufacturers about the nature of the stabilizers used; my experience has shown that they are sometimes sufficiently volatile to distil over with the hydrogen peroxide, if redistillation is employed as a precautionary measure.

Where stabilizer is present, it may very well happen that the hydrogen peroxide will be less effective by a considerable factor than the same concentration produced in clean water by ionizing radiation. In the course of studies on the effects of radiation on dilute aqueous suspensions of bacteriophage, I have made use of hydrogen peroxide from various sources, and only occasionally has the commercial product had as much effect as that formed by radiation. For example, in one series of experiments the survival curve for phage exposed to 50 γ/ml. of a redistilled commercial hydrogen peroxide was matched by that for phage exposed, in otherwise identical conditions, to about 1 γ/ml. of hydrogen peroxide, produced by 15,000 r. of X-rays.

It seems probable that, for the same reasons, the effects of metabolically produced hydrogen peroxide cannot safely be judged by experimenting with the commercial product. Experimenters in this field, too, may find it useful to work with hydrogen peroxide which is unequivocally free from stabilizer. Ionizing radiation offers a fairly quick and easy method of producing it, provided only low concentrations are required.

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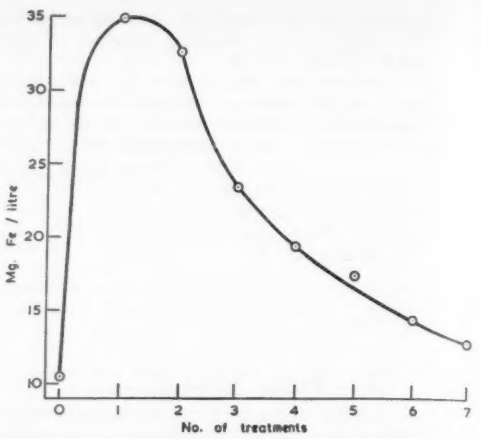
Sesquioxide Immobilization and Clay Movement in Podzolized Soils

Aqueous leachates of coniferous and broad-leaved forest litter readily dissolve hydrated ferric and aluminium oxides with the formation of soluble ferrous and aluminium complex compounds[1]. Further work on the properties of these complexes has shown that both the iron and aluminium compounds are strongly sorbed by soil sesquioxides and clay minerals.

It was previously suggested that the formation of the bleached A_2 horizon of a podzolized soil is caused by the solvent action of the leachates; it now seems that the subsequent immobilization of sesquioxides, which leads to the formation of the B horizon, is due to sorption of the iron and aluminium complexes on soil colloids, in particular the unattacked sesquioxides.

The sorption effect appears to be particularly marked in the case of the rimu (*Dacrydium cupressinum*) of New Zealand. If ferric oxide is treated with an aqueous rimu leaf extract, oxygen being excluded, the rate of solution of the oxide decreases until, after some three to four weeks, very little further increase in the concentration of dissolved iron takes place. At this stage the residual ferric oxide has acquired a very intense black colour. If the rimu–ferrous solution thus obtained is left in contact with fresh ferric oxide for a comparatively short period, it is found that extensive solution takes place —in a typical experiment, in 2 hr. the additional solution amounted to nearly 10 per cent of that obtained initially in 30 days. If the rimu solution is treated successively with fresh ferric oxide, the initial solution effect is quickly exhausted and gives place to an equally pronounced sorption of the dissolved iron. This sequence is illustrated by Fig. 1, which gives the results obtained by agitating a rimu–ferrous solution with ferric oxide for 15 min. and treating the centrifuged solution with fresh ferric oxide. The ratio of volume of solution/weight ferric oxide was the same in each treatment, so that this procedure reproduced the effect of percolating the original solution down a column of ferric oxide. It is significant, therefore, that the diagram corresponds to the distribution of iron down a podzolized profile; the solution stage represents the formation of the A_2 horizon, and the sorption stage that of the B horizon.

Percolation of a rimu–ferrous–aluminium solution down a column of ferruginous sand resulted in a net



sorption of iron and aluminium, neither of which could be completely recovered by washing the column with water.

The experimental results thus indicate that sorption of the reaction products takes place concurrently with the solution process, and that the sorption has the effect of inhibiting further solution of the ferric oxide.

It has been found that the leachates can induce a marked deflocculation of both kaolinitic and montmorillonitic clay minerals. A calcium-flocculated suspension of montmorillonite which has been dispersed by addition of an aspen leaf extract may be reflocculated by addition of further calcium ion. Thus the concentrations of clay found in the B horizon of the Grey Wooded Soils of central North America, which are formed on calcareous materials under a predominantly aspen cover, may be produced by the leachates dispersing clay in the upper levels and transporting the dispersed material to lower horizons, in which the concentration of calcium remains sufficiently high to cause reflocculation and consequent immobilization.

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Paper Electrophoresis of Streptomycins

Mannosidostreptomycin in some streptomycin preparations is conveniently detected by the paper chromatographic procedure of Winston and Eigen[1]. In the presence of high concentrations of salts such as in ion-exchange column eluates, or in fermentation broths, this procedure is not applicable: attempts to desalt such solutions, by mixed-bed ion-exchange, electrolytic de-ionization or solvent extraction, have proved unsuccessful. We have found it possible to separate streptomycin, mannosidostreptomycin and allied substances by paper electrophoresis, having developed (independently) a technique similar to that used for new antibiotic broths by Hosoya *et al.*[2], and King and Doery[3].

The apparatus is simple and consists of (*a*) a pair of electrode vessels ('Pyrex' dishes, 17 cm. × 27 cm. × 5·5 cm.), in each of which is situated a pure graphite electrode (20 cm. × 2·5 cm. × 0·5 cm.) with a platinum lead; (*b*) the support and cover for the filter paper (a pair of planar sheets of plate glass 28 cm. × 58·5 cm.), arranged horizontally on levelling screws between the electrode vessels. A cooling system was found to be unnecessary with a power pack providing 0–100 m.amp. at 300 volts.

Several grades of filter paper were examined; the most regular spots and highest loadings were obtained with Whatman No. 31 (thick). The paper is cut to size (24 cm. × 70 cm.), and the origin line is drawn 7·5 cm. from one end.

The solutions to be examined are applied to the origin line from a micrometer pipette, and the spots are allowed to dry. The paper is wetted evenly with *p*H 5·0 buffer (700 ml. 0·2 *M* sodium acetate plus 300 ml. of 0·2 *N* acetic acid) to within 0·5 cm. of each side of the origin line. The paper is blotted between blotting paper with a rubber roller and placed in position on the bottom sheet of levelled plate-glass, and the upper glass sheet is laid on top. About 300 ml. of buffer solution is added to each electrode vessel. The end of the paper farthest from the origin line is dipped into the cathode vessel, and the buffer is allowed to rise up the paper until the origin line is wetted and electrolyte continuity thus established. The end of the paper nearest the origin line is then dipped into the anode vessel, and the current is switched on. Sixteen hours later (overnight) the current is turned off and the paper is removed and dried, ready for spraying or laying on an agar plate seeded with a suitable organism[1].

We have examined a number of spray reagents; the following modified reagents are all suitable for detecting small quantities of streptomycin on paper.

(*a*) A diacetyl spray[4], which indicates streptomycin by means of its guanido groupings. The reagent (equal volumes of 0·1 per cent v/v aqueous diacetyl, 20 per cent w/v aqueous potassium hydroxide and 2·5 per cent w/v alcoholic α-naphthol mixed, in the order given, immediately before use) is sprayed on the air-dried paper. A magenta colour develops within a few minutes at room temperature if 5 μgm. or more of streptomycin equivalent is present.

(*b*) A naphthoresorcinol spray originally described[5] for the detection of carbohydrates, with a sensitivity for streptomycin similar to that of (*a*). The dry paper is sprayed evenly with the reagent (0·5 gm. of naphthoresorcinol dissolved in 225 ml. of ethanol and acidified with 25 ml. of concentrated orthophosphoric acid) and dried in an air oven at 100° C. for a minute or two until the background is faintly pink. The streptomycin spots are strongly fluorescent when viewed in ultra-violet light. In much higher concentrations the spots are visible in daylight, that from mannosidostreptomycin being pink and from streptomycin greyish.

(*c*) A spray reagent suggested by Partridge[6] for the detection of glucosamine, based on the Elson–Morgan reaction. The dry paper is sprayed with solution *A* (5 ml. of 50 per cent w/v alcoholic potassium hydroxide mixed, just before use, with 100 ml. of 1 per cent v/v acetyl acetone in redistilled *n*-butanol) and is heated in an oven at 100° C. for five minutes. After cooling, it is resprayed with solution *B* (0·5 gm. of *p*-dimethylaminobenzaldehyde dissolved in 15 ml. of ethanol, acidified with 7 ml. of concentrated hydrochloric acid and added to 90 ml. of redistilled *n*-butanol). Pink spots appear after reheating in the 100° oven for two or three minutes. This spray reacts with the N-methylglucosamine portion of the molecule. The reaction is somewhat less sensitive than that of (*a*) or (*b*).

A single paper may be used for sprays (*a*) and (*c*). The paper is first sprayed with the diacetyl reagent and the resultant spots are outlined before treatment with the Elson–Morgan sprays. It is necessary to use a separate paper for the naphthoresorcinol spray.

Table 1

Substance	Mobility ($\mu \times 10^{-4}$)
Streptomycin	22·5
Mannosidostreptomycin	19·5
Streptothricin	24·0
Streptidine	24·9
Streptamine	6·3

Table 1 shows average values for mobility, μ, calculated from the formula $\mu = dl/vt$, where d is the distance in cm. from the origin to the centre of the spot, v is the average of initial and final voltages applied and observed, l is the length of the paper in cm., and t is the time of migration in seconds. (These values are not corrected for electro-endosmosis; the effect of this was tested with glucose and found to be negligible with the buffer and paper recommended.)

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Conjugated Phenols in the *Fusarium* Wilt Syndrome

Vascular discoloration is a prominent symptom of *Fusarium* wilt of tomato. Phenols are naturally occurring substances capable of discolouring plant tissues upon oxidation by phenoloxidases and polymerization to melanins. Phenoloxidases have been shown to occur in tomato stems[1]. Accordingly, the pathogen, *Fusarium oxysporum* f. *lycopersici*, could cause vascular discoloration by liberating phenols into the host's vascular system.

Initial experiments demonstrated that certain phenols are capable of discolouring the vascular bundles of tomato stems. Bonny Best tomato stems placed in solutions of phenols show vascular discoloration (but not wilting) within 3–24 hr., depending on the phenol, dosage and rate of transpiration. Orthopolyphenols are most active, certain metapolyphenols have slight activity, and one monophenol, carbolic acid, exhibits some activity (Table 1). Significantly, the vascular sap, exuded by root pressure from the stumps of diseased plants, contains more phenols than the sap of healthy plants. Mushroom phenoloxidase discolours the vascular sap of diseased

Table 1. Vascular Discoloration of Bonny Best Tomato Cuttings caused by Phenols at 100 p.p.m.

Compound	Discoloration after 24 hr.*	
	of ambient solution	of vascular system
Pyrogallol	+ + +	+ + + +
Gallic acid	+	+ + + +
Catechol	+	+ + + +
Tannic acid	+	+ +
Protocatechuic acid	− − −	+
Gentisic acid	+	+
2,4-Hydroxybenzoic acid	− − −	− − −
Phloroglucinol	+	+ +
Resorcinol	− − −	+ +
Hydroquinone	+ +	+ +
p-Cresol	+	+
Tyrosine	− − −	+
Carbolic acid	+	+ + +
Distilled water	− − − −	+

* (+) Discoloration relative to pyrogallol. Part, if not all, of the discoloration of the ambient solution is due to auto-oxidation of the phenol.

plants but is without effect on the sap of healthy plants. Thus, the evidence suggests that phenols are responsible for vascular discoloration in the diseased tomato stem. Accordingly, experiments were performed to determine the source of the phenols found in the sap of diseased plants.

The production of phenols by *F. oxysporum* f. *lycopersici* in artificial culture was examined. Neither phenols nor phenoloxidase was detected in the culture filtrate obtained from the growth of *F. oxysporum* f. *lycopersici* on an inorganic salt – glucose medium. This was demonstrated by the failure of two phenols, catechol and pyrogallol, or mushroom phenoloxidase to discolour the filtrate.

Although the pathogen may not be capable of synthesizing phenols, the phenols detected in the vascular sap of diseased plants could arise by the action of hydrolytic enzymes, produced by the pathogen, on the native conjugated phenols, such as glycosides, tannins or lignins, present in the host. The results in Table 2 demonstrate that *F. oxysporum* f. *lycopersici* can utilize salicin and tannic acid as the sole source of carbon for growth on Czapek's inorganic nutrient supplemented with micro-elements. The pathogen grew equally well on $\frac{1}{2}$ per cent sucrose ($7{\cdot}6 \times 10^{-3}$ molar), $\frac{1}{4}$ per cent salicin ($8{\cdot}8 \times 10^{-3}$ molar) and $\frac{1}{2}$ per cent tannic acid ($15{\cdot}5 \times 10^{-3}$ molar). Growth was inhibited by higher concentrations of salicin and tannic acid. This experiment suggests that the pathogen produces hydrolytic enzymes which liberate phenols from β-glucosides and tannins.

A β-glucosidase capable of splitting salicin was detected in the sap of diseased plants, but not in that of healthy plants. 0·5 ml. of vascular sap was added to 10 ml. of 0·005 *M* salicin in 0·1 *M* acetate, *p*H 5; 1 ml. of toluene was added to each tube to preserve the reaction mixture. The tubes were incubated at room temperature (21 ± 1° C.). At fixed intervals 0·5 ml. of two-fold diluted Folin–Ciocalteu

Table 2. Growth of *F. oxysporum* f. *lycopersici* on Salicin, Tannic Acid and Sucrose as the Sole Source of Carbon

Carbon source	Concentration $\times 10^{-3}$ molar	Mycelium dry weight (mgm.)
Sucrose	7·6	12
Salicin	8·8	14
Salicin	17·6	17
Salicin	35·2	14·5
Tannic acid	15·5	12·5
Tannic acid	31·0	0·00

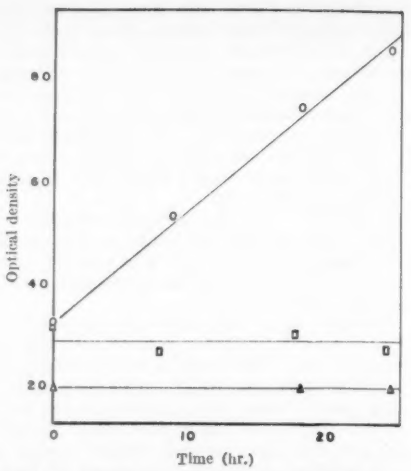

Fig. 1. β-Glucosidase activity of the vascular sap of diseased and healthy plants as measured by the hydrolysis of salicin. ○, diseased; □, diseased boiled; △, healthy. Optical density signifies the colour intensity of the incubated enzyme-substrate reaction mixture after treatment with Folin–Ciocalteu phenol reagents. The difference in optical density of the vascular sap of diseased and healthy plants at the zero hour is due to the higher concentration of phenols in the vascular sap of diseased plants as identified with mushroom phenoloxidase

phenol reagent[2] was added to the reaction mixture, followed by 2 ml. of 20 per cent sodium carbonate. The tubes were shaken vigorously for 25 sec., placed in boiling water for 1 min., and immediately cooled with tap water. The intensity of the blue colour developed in the tubes by this treatment was measured with a Fisher electrophotometer using a 650-mμ filter. The coloured reaction product was diluted twofold prior to measurement. The results in Fig. 1 demonstrate the presence of an enzyme hydrolysing salicin in the vascular sap of diseased plants which was destroyed when placed in a boiling water-bath for 5 min. Enzyme activity was not detected in the vascular sap of healthy plants. Thus, the phenols found in the vascular sap of diseased plants could arise by hydrolyses of β-glucosides in the host. The carbohydrate fraction freed from the conjugated phenol might possibly function in the wilting mechanism characteristic of *Fusarium* wilt of tomato. Hodgson *et al.*[3] have shown that polysaccharides can cause plants to wilt.

Significantly, if the base of a healthy tomato cutting is placed in a small volume of distilled water, the stem will develop vascular discoloration. Conceivably, all the components of the system responsible for vascular discoloration could arise from the host. Disruption of the host cells by the pathogen might liberate the factors responsible for the disease symptoms into the vascular system.

To summarize, phenols evidently are responsible for vascular discoloration in tomato plants infected with *F. oxysporum* f. *lycopersici*. The free phenols are probably derived from the host's conjugated phenols by the action of hydrolytic enzymes, produced by the pathogen. The host's phenoloxidase oxidizes the free phenols to coloured products. The same mechanisms could function in other plant diseases where vascular discoloration is a factor in the disease syndrome.

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Utilization of Acetate in Experimental Diabetes

IT is well known that acetic acid occupies an important place in the intermediary metabolism, and that the participation of this substance in many reactions requires the activation of the acetate molecule. It is now generally considered that 'active acetate' corresponds to acetyl coenzyme *A*. Therefore, it appears reasonable to assume that a reduction of the acetylation of coenzyme *A*, that is, of the formation of 'active acetate', would lead to the accumulation of acetic acid.

It has been shown that acetic acid concentration in the urine of diabetics is higher than that of normal urine[1]. This may be attributed either to an increased acetate production or to a reduced acetylation of coenzyme *A* or both.

In order to test *in vivo* the extent of utilization of acetate in diabetes, normal and depancreatized dogs fasted 12 hr. were injected intracardially with different volumes of an acetic acid buffered solution. The doses employed were as follows: 100, 150 and 250 mgm./kgm. body-weight, expressed as acetic acid. Acetate solution of *p*H 7·4 was made by adding an appropriate amount of sodium acetate to acetic acid. The acetic acid concentration in the blood was estimated before the acetate inoculation and at various intervals after the inoculation (1, 5, 10, 15, 30 and 60 min.), according to a method previously described[2]. The acetic acid concentration in urine was also determined before and after acetate administration. It was found that, even before inoculation, the acetate-level in arterial blood was higher in the diabetic (average 11·2 mgm./100 ml.) than in the normal dogs (average 7·0 mgm./100 ml.). The injected acetate disappeared very rapidly from the blood of normal animals, whereas in diabetics it persisted for a longer period. In normal and depancreatized dogs, the rate of disappearance of acetate depends upon its initial concentration in the blood; hence the amount of acetate transformed in a given period is proportional to the amount injected. Taking as a representative index of the phenomenon the half-time for the recovery of equal quantities of acetic acid from the blood after the acetate injection, the values shown in Table 1 were obtained:

Table 1. HALF-TIMES FOR RECOVERY OF EQUAL QUANTITIES OF ACETIC ACID FROM BLOOD AFTER ACETATE INJECTION

Dose injected	Normal dog (min.)*	Diabetic dog (min.)*
100 mgm./kgm. body-weight	5	26
150 " " " "	4	15
250 " " " "	3	7

* Average of at least three experiments.

Acetate determinations in urine have shown that, under our experimental conditions, the amount of injected acetate eliminated by way of the kidneys may be neglected. Since 100 mgm./kgm. body-weight appeared to be the smallest dose necessary to make the phenomenon appreciable, such a dose has been chosen as standard for the study of the behaviour of ketone bodies after acetate administration. We found that in the normal dog the increase of the blood-ketone level was very small and fleeting after acetate injection, whereas in the depancreatized dog such an increase was much greater and lasting. The average values obtained are summarized in Table 2.

Table 2. THE BEHAVIOUR OF BLOOD KETONE BODIES AFTER INJECTION OF 100 MGM. OF ACETIC ACID/KGM. BODY-WEIGHT

	Total ketones in blood expressed in terms of β-hydroxybutyric acid (mgm./100 ml.)	
	Normal dog*	Diabetic dog*
Before inoculation	0·85	10·5
1 min. after inoculation	1·10	11·0
5 " " "	1·40	12·5
10 " " "	0·85	13·1
15 " " "	0·90	13·0
30 " " "	0·92	11·5
60 " " "	0·92	11·3

* Average of at least three experiments.

It is to be noted that the labelled acetate, injected either into an intact or an eviscerated animal, is oxidized to carbon-14 dioxide[3,4], and that in our experiments acetate administration leads to the production of ketone bodies. These facts indicate that the injected acetate has been rapidly activated. The marked difference in speed of disappearance of injected acetate observed between normal and depancreatized dogs shows that the utilization of acetate in diabetes is reduced compared with the normal. Since without activation acetate is a metabolically inert form, it tends to accumulate and to be eliminated with urine in greater amount than normal.

These observations suggest that in diabetes, in addition to other known enzymatic changes, the acetylation of coenzyme *A* is reduced.

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Effect of Five Strains of Fowl-Plague Virus on a Sulphonphthalein Dye

KUNST[1] examined the effect of different strains of influenza virus on sulphonphthalein dyes and found that when various dyes of this group were inoculated into the allantoic fluid of eleven-day old chick embryos in the presence of swine influenza virus they faded after 48 hr., whereas the human strain of influenza virus *A* induced much less change though the hæmagglutination titres of the two strains were more or less similar.

The following experiment was carried out in an attempt to differentiate between five different strains of fowl-plague virus using one of the sulphonphthalein dyes, namely, phenol red. The virus strains used were :

Fowl-plague, original strain	$PFC_2P_{11}C_{35}$
Fowl-plague, attenuated strain,	$PFC_2P_{11}C_{30}P_{25}C_1$
Fowl-plague, reactivated strain,	$PFC_2P_{11}C_{30}P_{25}C_{15}$
Fowl-plague, mice strain,	$PFC_2P_{11}C_{30}M_{62}C_1$
Fowl-plague, tyroid strain,	T_{111}

The experiment was carried out in the following steps : (1) A 1 : 1,000 solution of the dye in 0·01 *N* sodium hydroxide was prepared. (2) 3 ml. of 10^{-2} solution of the virus in phenol red was inoculated into the allantoic cavity of three eleven-day old eggs ; three chick embryos inoculated with phenol red alone served as controls. (3) The inoculated embryos were incubated at 37° C. for 48 hr. and the allantoic fluid of each egg was aspirated separately and tested for freedom from bacterial contamination. (4) The colour intensity of the sterile chorio-allantoic fluid was determined, arbitrary units being given to designate this intensity ; ++++ indicated the original deep red colour of phenol red, while 0 represented complete discharge of the red colour. All degrees of intergradation which existed between these two extremes were given respective arbitrary units between these two.

The results obtained from the above experiment are presented in Table 1.

Table 1. Effect of Five Different Strains of Fowl-Plague Virus on Phenol Red in Chick Embryos

Virus strain	Colour intensity of chorio-allantoic fluid (arbitrary units)
Phenol red (control)	++++
Fowl-plague, original, $PFC_2P_{11}C_{35}$	++++
Fowl-plague, attenuated, $PFC_2P_{11}C_{30}P_{25}C_1$	+++
Fowl-plague, reactivated, $PFC_2P_{11}C_{30}P_{25}C_{15}$	++
Fowl-plague, mice, $PFC_2P_{11}C_{30}M_{62}C_1$	++±
Fowl-plague, tyroid, T_{111}	±

The results in Table 1 show that the five strains of fowl-plague virus used in this experiment possess varied powers of discharging the colour of phenol red in allantoic fluids inoculated with each of them separately. Thus the reactivated strain induced a notable decrease in the colour intensity of the allantoic fluid as compared to the controls. The change in intensity was much less when the dye was inoculated together with the attenuated strain, whereas the original strain of fowl-plague virus failed to induce any change in the colour intensity. The change in colour by the mice strain was of intermediate nature between that induced by the attenuated and reactivated strains, while the tyroid strain induced almost complete discharge of the colour of the infected allantoic fluid.

Determination of the *p*H-value of the infected chorio-allantoic fluids showed that the decrease in the colour intensity was accompanied by a similar decrease in the *p*H value. Thus, the chorio-allantoic fluid inoculated with the original strain which showed a deep red coloration very similar to that of the control gave a *p*H-value of 8·0, while that infected with the tyroid strain had a *p*H value of 6·3, which would explain the complete discharge of colour of phenol red by this virus. This result is, however, contrary to the findings of Kunst (*loc. cit.*), who claimed that there was no change in the *p*H of the allantoic fluid during the development of swine influenza and human influenza *A* viruses, though they induced different changes in the colour intensities of the allantoic fluid inoculated with a mixture of each of them and a series of sulphonphthalein dyes.

It is suggested that this method, if worked out thoroughly, might serve as an easy means of separating closely related virus strains.

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A Selective Method for the Staining of Negri Bodies in Histological Brain Sections

Several techniques have been devised for the demonstration of Negri bodies in histological preparations ; but many of them, in my experience, proved to be sometimes capricious and not always reliable. Hitherto, in this laboratory routine examinations for rabies are carried out by staining sections of the hippocampus with a slightly modified Heidenhain's iron hæmatoxylin. This technique was found to be extremely reliable, and Negri bodies appear as blue-black well-defined structures, often containing black granules and vacuoles. However, as the whole background is greyish-black and red blood corpuscles, glial cells and leucocytes stain black also, some confusion may occasionally be encountered while differentiating Negri bodies. In view of this drawback, another method has been evolved, which gives very selective, durable and constant staining of Negri bodies.

The method described below is based upon picro-Mallory modifications of Lendrum and McFarlane[1] and McFarlane[2]. The picro-Mallory techniques were originally devised for the staining of connective tissue ; however, advantage has been taken of the principles of the method in order to demonstrate Negri bodies.

The method is as follows. Stain paraffin sections in Ehrlich's hæmatoxylin (5 min.). Blue in tap water for 2 min. Orange *G* ½ per cent in saturated aqueous solution of picric acid (1 min.). Wash in tap water until only erythrocytes remain stained yellow. Rinse in distilled water and stain for 10 min. in the following solution : acid fuchsin (0·5 gm.), phosphotungstic acid (0·5 gm.), 1 per cent acetic acid (100 ml.). Rinse in distilled water and differentiate for 5 min. in the following solution : phosphotungstic acid (2 gm.), phosphomolybdic acid (2 gm.), saturated aqueous picric acid (70 ml.), absolute alcohol (30 ml.). Rinse in distilled water and then in 1 per cent acetic acid. Stain for 15 min. in 1 per cent anilin blue in 2 per cent aqueous acetic acid. Rinse in 1 per cent acetic acid, dehydrate, clear and mount.

Negri bodies are stained purplish-red with blue granulations, cytoplasm of neurones bluish, nucleoli dark purple and erythrocytes yellow.

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Stimulation of the Growth of the Radicle after Treatment of Tomato Seed with Bromine Water

During investigations into the minimum time necessary for surface-sterilization of tomato seed with bromine solution, it was noted that certain treatments stimulated growth of the radicle.

Hybrid seeds obtained from the crossing of two inbred lines of tomato (*Lycopersicum esculentum*, Mill.) were used in all experiments. The inbred lines were derived from the varieties Pritchard and Red River. Pritchard was used as the maternal parent. Samples of seed were immersed in a 0·5 per cent solution of bromine (vol./vol.) for varying lengths of time and then washed quickly with sterile distilled water until all coloration disappeared.

The effect of time of immersion in bromine solution on growth of the radicle, with seed germinated in the sterile standard medium[1] used for culture of excised tomato roots, is shown in Table 1.

Table 1. Effect of Increasing Time of Immersion of Seeds in Bromine Solution on Length of Radicle, Number of Lateral Roots per Radicle and Length of First Lateral at Seven Days after 'Sowing' (Seeds Germinated in White's Medium)

Length of bromine treatment (min.)	Mean length of radicle (mm.)	Number of laterals per radicle	Mean length of first lateral (mm.)
½	67·0 ± 4·06 (11)	12·5 ± 1·50	15·3 ± 2·80
1	75·6 ± 3·52 (13)	13·6 ± 1·72	17·1 ± 1·45
2	79·1 ± 3·40 (11)	14·5 ± 1·53	22·5 ± 1·91
4	73·7 ± 4·06 (12)	10·9 ± 0·81	19·8 ± 2·19

The results show that growth in length of either the radicle or the first lateral, and number of laterals, were greater with an immersion time of 2 min. compared with an immersion time of 0·5 min. The experiment was repeated with seed germinated on moist filter paper in sterile Petri dishes. Observations of the number of seeds germinated were made at 30, 42, 48 and 102 hr. after sowing, at which time the radicles were measured. Results are shown in Table 2.

Table 2. Length of Radicle at 102 hr. after Sowing with Seeds Subjected to Different Periods of Treatment with Bromine Solution

Length of bromine treatment (min.)	All seeds germinated by 42 hr. after sowing		All seeds germinated by 42 hr. after sowing, but with radicles less than 2 mm. long	
	No. of seeds	Mean length of radicle (mm.)	No. of seeds	Mean length of radicle (mm.)
0	36	34·8 ± 0·935	31	33·7 ± 0·950
½	30	51·2 ± 1·738	19	48·1 ± 1·37
1	33	50·3 ± 1·650	22	46·1 ± 1·79
2	25	45·7 ± 1·192	15	43·9 ± 1·56
6	27	33·0 ± 1·289	18	32·1 ± 1·26

A second run with seed germinated on moist filter paper was made using a greater number of replicates and germination observed at 24, 30, 33, 36, 42, 48, 54, 66 and 102 hr. after sowing. The lengths of radicles at 102 hr. after sowing were 40·5 ± 1·32 (103) for untreated seed and 60·5 ± 1·32 (104) for treated seed.

There was no detectable effect of bromine treatment on either viability or 'germination-rate' in either run. Bromine treatments of ½, 1 and 2 min. produced an increase in growth of the radicle compared with untreated seed. Growth of radicles with seed treated for 6 min. was less than that in the other bromine treatments.

The evidence is insufficient to justify any conclusions as to the mode of action of bromine on growth of the radicle. The fact that bromine treatment gave stimulation with seeds germinated either when immersed in culture solution or on moist filter paper indicates that there is a direct effect on the seed or radicle, and not an indirect effect due to reaction of bromine with some unfavourable environmental factor. Taylor[2], using celery seed, showed that either time of emergence of the radicle with seed sown in Petri dishes, or time of emergence of the seedling with seed sown in soil, was decreased when the seed was treated with calcium hypochlorite. Similar treatment also decreased time of emergence of pre-sprouted seed sown in soil. Similar experiments using seed of tomato (hybrid Pritchard × Red River) sown in soil have been carried out at my present address. No decrease in time of emergence and no increase in height or dry-weight of the seedlings was detected at two weeks after sowing.

Burkholder and McVeigh[3] found that treatment of seeds with calcium hypochlorite may affect the formation of niacin, pantothenic acid and riboflavin during germination. Consideration of these points suggests that synthesis of the vitamins may be related to a process which is affected by halogen oxidizing agents, and that radicle growth in the tomato hybrid used here may be limited by the balance of vitamins synthesized during germination and early growth.

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A *Chalaropsis* on Beech

During an investigation of fungi on recently felled beech, attention has been directed since April 1952 to an abundant fungus in Knole Park, Sevenoaks, which sporulates at the interface between wood and bark. It is also abundant, but in small patches only, on the sap-wood of stumps.

Externally normal bark can be removed a month after felling to expose a black sludge, sometimes 3 ft. in length, of thallospores of an apparently undescribed species of *Chalaropsis*. Intermixed with this are infrequent perithecia of a species of *Ceratocystis* (*Ophiostoma*), with a brimmed ascospore, which culture has shown to be the perfect stage of the *Chalaropsis*. As well as the blackish thallospores, hyaline endospores are formed both on the wood and in culture. Further, intermixed with the sludge are other species of *Ceratocystis* but in small amount. Woodlice, commonly seen below the bark of affected felled trees, leave a frass consisting largely of viable thallospores of *Chalaropsis*.

Chalaropsis thielavioides Peyronel, causing walnut graft disease in Great Britain[1], is the only previous record of a species of the genus in Britain; but the perfect stage is unknown and the thallospore measurements are significantly different from those of the *Chalaropsis* on beech. The only other *Ceratocystis* with a brimmed ascospore and a *Chalaropsis* stage is *Endoconidiophora variospora* Davidson, reported from oak tan bark in the United States[2]; but this also seems to differ from the beech species.

There is no definite evidence that the fungus attacks living trees; but field observations have shown an initial infection of wounds in standing trees.

Sometimes the *Chalaropsis* and more frequently the accompanying *Ceratocystis* spp. are parasitized by *Gonatobotryum fuscum* Sacc., its parasitism showing some similarity to that of *Gonatorrhodiella highlei* A. L. Sm. on *Nectria*[3].

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Chemical Mutagenesis in Bacteriophage T2

Proflavine (2·8 diamino acridinium sulphate, Abbott) in concentrations of 3–4 γ/ml. prevents liberation of infectious bacteriophage *T2* from *Escherichia coli*, strain *B*, without preventing lysis[1]. The bacteria liberate incomplete non-infectious phage particles[2]. If proflavine is removed before lysis, the yield of complete phage is normal or subnormal. We have detected a mutagenic effect on phage produced in proflavine-treated bacteria.

E. coli B was infected with phage *T2* in a synthetic medium (glucose, 4 gm.; ammonium chloride, 1 gm.; magnesium sulphate, 0·12 gm.; disodium hydrogen phosphate, 6 gm.; potassium dihydrogen phosphate, 3 gm.; water, 1,000 ml.; *p*H 7·0), with or without 4·0 γ/ml. proflavine added at the time of infection. Proflavine was removed 17 min. after infection by a 1 : 100 dilution. The phage yield from proflavine-treated cultures contained many more plaque-type mutants *r* and *w* (see ref. 3) than the control phage yield (see table).

	Mutants *r* and *w* in bursts of phage *T2*					
	No. of plates	Average No. of bursts per plate	No. of bursts examined	Plates with mutants	Total yield	Total mutants
Exp. 1						
Control	100	2·7	270	1	25,000	15
Proflavine 4·0 γ/ml.	100	2·65	265	43	26,000	201
Exp. 2						
Control	40	4·1	165	2	—	9
Proflavine 4·0 γ/ml.	42	4·3	180	28*	—	123

* Four plates had mutants of two distinct plaque types.

The mutants include the same variety of plaque types as the spontaneous mutants. In the yields from individual bacteria the mutants are distributed in clones, with distribution of clone size roughly similar to that observed with spontaneous mutants[4]. The effect of proflavine appears, therefore, to be an increase in mutation-rate over the rate of spontaneous mutations. Experiments directed towards detecting any selection by proflavine in favour of plaque-type mutants were negative. There was no preferential loss of clones containing r^+ phage only, nor any increase in the proportion of *r* particles in the yield of bacteria infected mixedly with $T2r^+$ and *T2r*.

Proflavine increased the frequency of *r* mutants in a *T2w* stock. In presence of proflavine, the rate of the mutation $T2r \rightarrow T2r^+$ was not increased enough over the spontaneous rate (about 10^{-7}) to allow detection of any r^+ mutants among 3×10^4 *r* particles from proflavine-treated bacteria. Preliminary experiments indicate a slight effect of proflavine on the mutation $T2 \rightarrow T2h$.

Proflavine is an effective mutagen for bacteria. Treatment of washed cells of a streptomycin-dependent strain of *E. coli*[5] with 4·0–20·0 γ/ml. proflavine (1 hr. at 37° C. in distilled water) produces no sterilization of bacteria but increases 6–10 times the number of colonies they produce on nutrient agar without streptomycin.

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Eye Movements in Connexion with Television Viewing

The present-day British system of television makes use of the line interlace system whereby frames, each containing only half the total picture information, are presented at the rate of 50 per sec. The advantage of this system compared with the sequential system, in which each frame contains the total picture information, is that it gives a subjective increase in the maximum amount of information that can be transmitted in a given band-width. A disadvantage of the interlace system is that pictures of still objects may show instability associated with the interlace, and those of vertically moving objects may appear non-interlaced with the raster drifting slowly in the direction of movement (that is, 'crawling'). Gouriet[1] has suggested that differences in the pattern of eye movement when viewing sequential and interlaced pictures could account for these phenomena.

Using the photoelectric corneal reflex apparatus[2], an investigation of the problem has therefore been made. Records have been obtained of the movements of one eye for binocular viewing of a 9-in. television screen for both sequential and interlaced scan with the picture present and with the picture suppressed. Viewing distances of 34 cm. and 120 cm. were used. The latter distance was the minimum for direct viewing that the configuration of the apparatus would allow; for the shorter distance, the subject viewed an image of the screen formed by reflexion in a plane mirror. Records for fixation of a pointer moving vertically across the screen for both sequential and interlaced scan with picture suppressed have also been obtained for the longer distance.

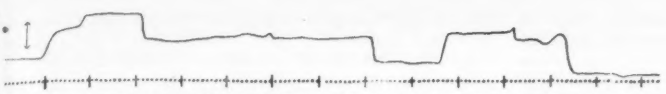

Fig. 1. Up and down right-eye record for subject R. F. V. for binocular fixation of an interlaced picture with considerable action; picture distance, 120 cm. Towards time-line corresponds to an upward movement. Time dots, 50 per sec. Height of arrowed line represents a rotation of 3°, assuming the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

The results indicate that, within the limits of sensitivity of the apparatus, there is little difference between eye movements for sequential and interlaced scan. For both types of scan, eye movements for fixation of the screen in the absence of the picture are similar to fixation eye movements previously reported[2,3]; the movements for the moving target are likewise similar to those previously investigated[4], although most subjects experienced 'crawling' for the interlaced scan. For both sequential and interlaced raster, the movements in the presence of a picture appear to depend on the picture content; part of such a record for interlaced scan is shown in Fig. 1.

Gouriet[1] has suggested that, in order to produce loss of interlace, the eye should, in 1/50 sec., move through an odd multiple of half the angle subtended by consecutive lines in any interlaced frame. For the smaller viewing distance, this angle is 7′; for the larger viewing distance it is 2′. Such movements would be readily detectable at the shorter viewing distance, since the limit of detection of the photo-electric corneal reflex method[5] is 1′. However, the records show no trace of 50 c./s. movements, although most subjects found the interlaced raster more unstable than the sequential.

This investigation would thus appear to indicate that the instability and 'crawling' associated with interlaced scan cannot be immediately explained in terms of the eye movement pattern.

I am grateful to the B.B.C. Research Department for collaboration in this investigation. I also wish to thank the other subjects, Dr. R. S. Longhurst and Dr. L. C. Thomson, with whom I have had several stimulating discussions. I am grateful to Mr. F. Hodgson for assistance with the recording and to Mr. G. Mallet for construction of the moving pointer. It is a pleasure to acknowledge the continued financial support of the Medical Research Council.

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Pre-Columbian Maize in Africa

While accepting the American origin of maize, the question of its existence in Europe before the days of Columbus has been revived by recent archæological finds in Yoruba territory. Goodwin (ref. 1, 13) states that pots decorated by rolling a maize cob over the wet clay have recently been found at Ife. "As vast numbers of specimens were collected from a pavement of potsherds that provided a clear-cut dating line for certain sites, it became important to note whether or not the maize cob decoration occurred. It did, and it is abundantly clear that this particular paving is subsequent to the introduction of maize."

The information now required is: In the reign of what Yoruba king was that pavement laid down, or when did maize reach the Yoruba? Yoruba tradition can at present throw light on the second question but not on the first. Burton (ref. 2, 1, 321) states that maize was introduced among the Yoruba by a yellow-skinned foreigner, who crossed the Niger from the north-east. A historian of the Yoruba, Moore (ref. 3, 4), states that the Kesi were the first to cultivate maize and that their king, Ojoko, decreed that no maize was to be sold to surrounding tribes unless it had been killed for planting by being first soaked in warm water and then dried in the sun.

Babalola (ref. 4, 14) states that the early centre of diffusion of the maize plant among the Yoruba was their original settlement of Ile Ife.

In none of these accounts is there any indication that maize reached the Yoruba from the sea-coast, as would be the case if the Portuguese introduced maize to West Africa.

An attempt will now be made to date these maize-cob decorated potsherds. Burns (ref. 5, 33) states that the first Yoruba capital was at Ile Ife and that during the reign of the fourth king the capital was moved to Oyo. It was while Ile Ife was still the capital that maize, according to Yoruba tradition, reached the Yoruba. Talbot (ref. 6, 1, 278) writes that between A.D. 600 and A.D. 1000, a wave of immigrants from the east invaded the Yoruba and made Ile Ife their capital, but later went to old Oyo. If, now, one takes the latest date for their invasion as, say, A.D. 1000, and that old Oyo was founded c. A.D. 1100, then it would appear that somewhere about this time maize appeared among the Yoruba. No dating much closer than this is at present possible; but what is quite clear is that the dates of the reigns of the Yoruba kings when maize first appeared among the Yoruba far antecedes the arrival of the first Europeans on the Yoruba coasts or the birth of Columbus.

This problem of the presence of maize in western Africa before the days of Columbus can be approached from another angle. My researches show that in Nigeria, as one progresses inland from the coast, the tribal names for maize indicate the route by which it migrated. Thus, the name for maize in tribe *A* is "sorghum of tribe *X*", where *X* is found ultimately to be the name of a tribe east or north of the receiving tribe *A*. Meek (ref. 7, 1, 252, 253, 39) writing of the Hegi, among whom the Kanuri language is widely understood, says that their name for maize is: "The guinea-corn (Sorghum) of the Kanuri", while among the Jukun the name is "the guinea-corn of the Pabir". Among the Yakutare the name is *Ajo Kwona*, or the *Sorghum* of the Kwona, alias Jukun. Among the Hausa the name for maize is *dawar masara*, where *dawa* = *Sorghum* and *Masa* = Egypt.

Here local traditions and maize names hold together and support the Yoruba tradition that maize reached them from the north-east. This confirmation of the Yoruba tradition indicates that the names of the Yoruba kings associated with the first appearance of maize reigned before Columbus was born.

There is also historical evidence to support Yoruba tradition. Monod, Teixeira and Mauny (ref. 8, 137),

in their account of Valentin Fernandez's visit to West Africa prior to 1506, report his statement that *milho zaburro* flourished in San Tomé where it was planted for the first time in 1502, having previously been shipped thither from the coast of Guinea. Here is evidence that *milho zaburro* was a well-established crop on the coasts of Guinea before 1502. If *milho zaburro* is maize, then it could not possibly be a well-established crop on the coasts of Guinea if it was first introduced into Spain in 1494, which is the earliest date by which Columbus could have introduced this cereal. It follows that if *milho zaburro* is maize, it must have existed in West Africa long before Columbus.

It is necessary to show that *milho zaburro* is maize. Soares de Sousa (ref. 9, 162), writing in 1587, says: "Dá-se autro-mantimento, em todo o Brazil, natural da mesma tena, a qui os indios chamam *ubatim*, qué é o milho de Guiné, que em Portugal chamam Zaburro . . ." Now *milho de Guiné* is still the name in Brazil for maize. A Portuguese dictionary of to-day gives: *Zaburro*, Indian corn, maize.

The question now arises: Who, then, brought maize to Africa before Columbus was born? My researches over the past seven years have now accumulated sufficient data[10] to establish Arab-Negro contacts with the Americas beginning about A.D. 900.

M. D. W. Jeffreys

University of the Witwatersrand,
Johannesburg, South Africa.

[1] Goodwin, A. J. H., *S. Afr. Arch. Bull.*, **8**, No. 29 (1953).
[2] Burton, R. F., "Abeokuta and the Cameroon Mountain" (London 1863).
[3] Moore, E. O. O., "History of Abeokuta" (London, 1916).
[4] Babalola, A., *West African Rev.*, **23**, No. 292 (1952).
[5] Burns, A., "A History of Nigeria" (London, 1929).
[6] Talbot, P. A., "Southern Nigeria" (Oxford, 1926).
[7] Meek, C. K., "Tribal Studies in Northern Nigeria" (Oxford, 1931); "A Sudanese Kingdom" (London, 1931).
[8] Monod, T., Teixeira, da Mota, and Mauny, T., "Description de la Côte Occidentale d'Afrique par Valentin Fernandez" (Bissau, 1951).
[9] Soares de Sousa, G., "Tratado descriptio do Brazil em 1587" (Rio de Janeiro, 1879).
[10] Jeffreys, M. D. W., *Scientia*, Juillet–Août (1953).

Non-standard Radio Propagation

Squadron Leader A. G. Sheffield, R.C.A.F. (VE3EB), has reported the following occurrence of non-standard radio propagation observed in Ottawa:

Date	Time (EDT)	Frequency	Location	Remarks
June 23	1900–2030	66–72 Mc./s.	WADS—TV Kansas City (915 n.m.)	Estimated signal up to 200 microvolts (received on indoor half-wave antenna)
June 24	1300–1400	60–66 Mc./s.	KMA—TV Omaha, Neb. (897 n.m.)	Steady signal with intermittent out of phase components displaced approx. 3 microseconds
June 24	1300–1400	66–72 Mc./s.	Not identified	Weak signal, origin unknown

He comments: "During this period, other long-range reception was evident over the frequency range of 54–72 Mc./s., but there was no opportunity for identifying it. Tests were made using a horizontally polarized co-linear antenna array consisting of four dual-stacked elements about 80 ft. above ground; 360° rotation of this antenna, which has a beam-width to 3 db. points of about 10°, did not change the strength or otherwise affect the signals observed. For the duration of this extraordinary long range very high-frequency reception, normal signals of a few microvolts from television stations about 100–180 miles distant could not be obtained".

The Rockcliffe weather office of the Department of Transport has very kindly furnished weather maps and an interpretation for the period June 21–25. It appears that the conditions at the time are very common for the region; these are a weak frontal surface giving a stable layer at about 10,000 ft. for the period of abnormality together with a surface inversion at about 1,000 ft. during the nights. *Radio-sonde* data are normally available at several points on or near the path.

P. G. Forsyth

Pinetree Project Office,
No. 4 Temporary Building,
Ottawa, Canada. July 7.

Zoological Nomenclature

Notice is hereby given of the publication of the following cases in the Class Aves involving the possible use of its plenary powers by the International Committee on Zoological Nomenclature for the purposes specified in brackets against each entry. Full particulars of these cases have been published in the *Bulletin of Zoological Nomenclature*, in Triple-Part 1/3 of Volume 9.

(1) *Colymbus* Linnæus, 1758, and *Gavia* (all uses prior to *Gavia* Forster, 1788) (suppression); (2) *caspicus* Hablizl, 1783, *Colymbus* (suppression); (3) *cafra* (*Otis*), *cafer* (*Cuculus*), *sulphuratus* (*Cuculus*), *flavescens* (*Lanius*), all of Lichtenstein, 1793 (suppression); (4) *nortoniensis* Gmelin, 1789, *Fringilla* (suppression); (5) *natka* (*Lanius*) and *septentrionalis* (*Lanius*), both of Gmelin, 1788, and *eimeensis* (*Columba*), *unalaschkensis* (*Hirundo*), *borealis* (*Motacilla*), *cirrhatus* (*Pelecanus*), *australis* (*Sterna*), all of Gmelin, 1789 (suppression); (6) *phaeus* (*Turdus*), *elegans* (*Motacilla*), *chlorotis* (*Muscicapa*), all of Forster, 1794, and *novaehollandiae* Latham, 1790, *Muscicapa* (suppression); (7) *Pyrrhocorax* Tunstall, 1771 (validation, for the Chough); (8) *philomelos* Brehm, 1831, *Turdus* (validation, for the Song Thrush); (9) generic name *Vermivora* and trivial names *lutea* (*Muscicapa*), *pensylvanica* [sic] (*Passer*), *americ.* [sic] (*Vermivora*), all of Linnæus, 1776 (suppression); (10) *migratoria* Linnæus, 1766, *Columba* (validation, for the Passenger Pigeon); (11) *Bubo* Duméril, 1806, *Coturnix* Bonnaterre, 1790, *Egretta* Forster, 1817, *Oriolus* Linnæus, 1766 (validation, by suppression of senior homonyms published by Brisson in 1760); (12) *Capella* Frenzel, 1801 (validation, by suppression of *Gallinago* Brisson, 1760); (13) *Myiobius* Darwin, 1839 (validation and designation of type species); (14) *cyanea* Hume, 1877, *Muscitrea* (validation, by suppression of *cyanea* Vieillot, 1818, *Muscicapa*); (15) *ferruginea* Hodgson, 1845, *Hemichelidon* (validation, by suppression of *ferruginea* Merrem, 1784, *Muscicapa*).

Comments on the above cases should be sent to me as soon as possible.

Francis Hemming
(Secretary of the International Committee on Zoological Nomenclature)

28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. G. L. Bailey: "Alloys" (Cantor Lecture). (Further Lectures on November 30 and December 7.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Frank Debenham: "New Light on Livingstone's Last Journey".

Tuesday, November 24

COMMUNICATION RESEARCH CENTRE (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. T. B. L. Webster: "Communication of Thought in Ancient Greece".*

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. F. M. H. Taylor: "The Conservation of the Nation's Fuel and Power Resources".*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; 6.30 p.m.—Dr. J. Haslam: "Physical Methods in the Analysis of Plastic Materials—Some Observations of an Analytical Chemist".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. R. D. Mylon: "Unusual Aspects of Automatic Control in the Chemical Industry".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, London, W.C.2), at 7 p.m.—Mr. B. Z. de Ferranti: "Machines, Animals and Information".

Tuesday, November 24—Wednesday, November 25

INSTITUTION OF GAS ENGINEERS (at Church House, Westminster, London, S.W.1), at 9.30 a.m. each day—19th Autumn Research Meeting.

Tuesday, November 24—Thursday, November 26

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Annual General Meeting followed by Symposium on Sinter.

Wednesday, November 25

BRITISH COUNCIL FOR REHABILITATION (in association with the UNIVERSITY OF SHEFFIELD, DEPARTMENT OF SOCIAL MEDICINE, in the University Medical Library), at 10 a.m.—Conference on "Can Disabilities be Overcome?"

POSTGRADUATE MEDICAL SCHOOL OF LONDON (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. C. Rimington: "Porphyrin Metabolism".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. A. P. Southwell: "Kuwait".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. F. G. Foster and Mr. A. Stuart: "Distribution-Free Tests in Time Series based on the Breaking of Records".

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. M. R. Gavin: "Electronics in Physics Courses".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. N. Troost: "A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverized-Fuel-Fired Boilers".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (joint meeting with the LONDON SECTION of the OIL AND COLOUR CHEMISTS ASSOCIATION, at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. C. E. Hollis and Mr. J. H. W. Turner: "Vinyl Emulsion Polymers and their Use in Coatings".

Thursday, November 26

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. A. Sholl: "The Anatomist and the Brain".*

Thursday, November 26—Friday, November 27

ROYAL INSTITUTE OF CHEMISTRY (in the Gas Showrooms (Basement), the Town Hall, Manchester), at 10 a.m. each day—Dalton Exhibition on the Measurement, Use and Application of Radioactive Substances.

Friday, November 27

INSTITUTE OF METALS (at the Royal Institution, Albemarle Street, London, W.1), at 10.30 a.m.—Informal discussion on "The Training of Metallurgists for Industry".

TEXTILE INSTITUTE (at 10 Blackfriars Street, Manchester 3), at 3 p.m.—Mr. B. M. Sweers (Arnhem): "Economic Aspects of the Textile Industry in Europe" (Emsley Lecture).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion: Mr. J. Squires, Mr. A. B. Malone, Mr. P. A. Rankin and Dr. S. K. Runcorn: "Airborne Magnetic Surveys". Chairman: Sir Harold Spencer Jones, F.R.S.

BEDSON CLUB (in Lecture Theatre II, The Chemical Laboratories, King's College, Newcastle-upon-Tyne 1), at 5.30 p.m.—Dr. J. R. Kenyon, F.R.S.: "Contributions to Optical Activity to the Study of Some Chemical Reactions".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. R. F. Darling: "Fuel Systems and Controls for Marine Gas Turbines": Mr. B. E. G. Forsling: "Main Propulsion Gas Turbine Set for the Oil Tanker *Auris*".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. Tomaschek: "The Tides of the Solid Earth and their Geophysical and Geological Significance".* (Further Lecture on November 30.)

ROYAL INSTITUTE OF CHEMISTRY (at the Town Hall, Manchester), at 7 p.m.—Sir John Cockcroft, C.B.E., F.R.S.: "The Development of Radiochemistry and Radiation Chemistry" (Eighth Dalton Lecture).

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the CAMBRIDGE UNIVERSITY CHEMICAL SOCIETY at the University Chemical Laboratory, Cambridge), at 8.30 p.m.—Prof. W. Baker, F.R.S.: "Some Aspects of the Chemistry of Phenols and Inclusion Compounds".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Alexander Fleming, F.R.S.: "Antibiotics".

Saturday, November 28

BOTANICAL SOCIETY OF THE BRITISH ISLES (in the Lecture Hall, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Annual Exhibition Meeting.

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the SCOTT POLAR RESEARCH INSTITUTE, at the Institute, Lensfield Road, Cambridge), at 8.30 p.m.—Prof. Gordon Manley: "Climatic Fluctuations and the Recent Behaviour of Glaciers".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with good honours degree, and postgraduate experience in physical chemistry, and suitable teaching experience) IN PHYSICAL CHEMISTRY, at the Leeds College of Technology—Chief Education Officer, Education Offices, Leeds 1 (November 25).

RESEARCH ASSISTANT IN PSYCHOLOGY to carry out experimental work in the Department of Psychology—The Registrar, The University, Manchester 13 (November 28).

SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in physics or physical chemistry) at the Department of Scientific and Industrial Research, Building Research Station, Bucknalls Lane, Garston, near Watford, for work on the flow properties of suspensions—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.278/53A. (November 28.)

ASSISTANT (with honours degree in biochemistry, agricultural chemistry or equivalent qualification) IN AGRICULTURAL BIOCHEMISTRY—The Secretary, The University, Aberdeen (November 30).

PHYSICAL CHEMIST or BIOCHEMIST (with research experience in the fields of enzyme or protein chemistry) in the Department of Medicine, to work under the direction of the newly appointed Nuffield Gerontological Fellow—The Registrar, The University, Leeds 2 (November 30).

ANALYST (with degree in chemistry or agricultural chemistry, and with experience in carrying out analyses on soils, fertilizers and other agricultural materials) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, Wye College, Ashford, Kent (December 5).

LECTURER IN PSYCHOLOGY at the University of Durham—The Secretary, 38 North Bailey, Durham (December 5).

LECTURER IN TEXTILE PHYSICS in the Department of Textile Industries, to undertake research on the structure and physical properties of fibres and related materials, using X-ray, electron microscope, ultra-centrifuge and infra-red techniques—The Registrar, The University, Leeds 2 (December 7).

CHIEF OF THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, Commonwealth Scientific and Industrial Research Organization, Australia, to be responsible for research activities in the fields of animal physiology, animal breeding, bacteriology, pathology and parasitology—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 200/31 (December 12).

RESEARCH OFFICER (Organic Chemist) (with honours degree in science or equivalent qualifications, and research experience in organic chemistry) at the Commonwealth Scientific and Industrial Research Organization, Wool Textile Research Laboratory, Parkville, Melbourne, to participate in an intensive programme of research on the structure of wool as a member of a group engaged in the synthesis of peptides, especially cystine peptides—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 464/72 (December 12).

RESEARCH OFFICERS (*a*) (with university honours degree in science, with chemistry as a major subject, or equivalent qualifications) to undertake physico-chemical studies of systems of importance in the utilization and chemical processing of minerals and their derivatives (Ref. 590/460); (*b*) (with university honours degree in science, with inorganic or physical chemistry as a major subject) to undertake general investigations on chemical derivatives of certain Australian minerals (Ref. 590/461), at the Commonwealth Scientific and Industrial Research Organization, Minerals Utilization Section, Division of Industrial Chemistry, Fishermen's Bend, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (quoting appropriate Ref. No.) (December 12).

LECTURER IN GEOGRAPHY (Grade 1), and a LECTURER IN MATHEMATICS (Grade 1), at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

PROFESSOR OF PHYSICS—The Secretary and Registrar, University College of North Wales, Bangor (December 15).

CHAIR OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Sheffield 10 (January 1).

RESEARCH ASSISTANT IN THE FLUID MOTION LABORATORY, to carry out experimental research on the aerodynamic noise generated by turbulent flows—The Registrar, The University, Manchester 13 (January 1).

SIR THOMAS LYLE FELLOWSHIP IN PHYSICS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 4).

ASSISTANT, Grade B (with good honours degree in chemistry and able to teach organic chemistry to final degree standard)—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

ASSISTANT LECTURER (Grade A) IN PHYSICS—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

BIOCHEMIST (with first- or second-class honours degree in biochemistry, biology or chemistry, and substantial experience in isolation of pure substances from biological materials) at the Ministry of Supply Radiochemical Centre, Amersham, Bucks, to take charge of group engaged in developing biological methods for synthesis of compounds containing carbon-14 and other radioactive isotopes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.532/53A.

DEMONSTRATOR, ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF PHYSICS—The Secretary and Registrar, The University, Southampton.

DIRECTOR (with first- or good second-class honours degree in a pure science and considerable postgraduate experience in microbiological research) OF THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, Trinidad—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/38/01.

GRADUATE IN PHYSICS to assist in research in space and water heating section—The Director, The Electrical Research Association, 5 Wadsworth Road, Greenford, Middlesex.

LECTURER or ASSISTANT LECTURER IN ANIMAL PHYSIOLOGY in the Department of Zoology—The Secretary and Registrar, The University, Southampton.

PHYSICAL CHEMIST (preferably Ph.D.) for research work on the kinetics of cellulose degradation—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PHYSICAL CHEMIST (with good honours degree) for research on wool fibres and problems related to wool processing, especially detergency—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

PLANT PATHOLOGISTS (2) (with first- or second-class honours degree, and preferably with two years or more postgraduate experience) in H.M. Colonial Service, West Africa, to work on the control of plant diseases by the use of fungicides—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 87/14/01.

RESEARCH ASSISTANT (with good honours degree in zoology and interested in vertebrate anatomy and embryology) IN MAMMALIAN GENETICS—The Secretary, University College, Gower Street, London, W.C.1.

RESEARCH ASSISTANT (with honours degree in physics or engineering) to the Principal of the College, to carry out research into the physical principles of the woollen textile processes—The Principal, Scottish Woollen Technical College, Galashiels, Selkirkshire.

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent in mathematics or physics) for operational research on a wide variety of problems, in London and the provinces, under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.285/52A.

TECHNICAL ASSISTANT (graduate in mathematical and/or physical science, and a good knowledge of at least one modern continental language, preferably German) IN THE SCHOOL OF THEORETICAL PHYSICS, for duties which will include scientific, secretarial and library work—The Registrar, Dublin Institute for Advanced Studies, Dublin.

UTILIZATION OFFICER (with degree in forestry and experience in timber exploitation and saw-milling operations) IN THE FORESTRY DEPARTMENT, Gold Coast Local Civil Service, to conduct detailed investigations into the resources and potential uses of local timber, and to advise on extraction and conversion methods and improvement of timber seasoning and grading—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.61/13/04.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Thirteenth International Horticultural Congress, 1952: London, 8–15 September. 2 volumes. Vol. 1: Pp. xv+576+39 plates. Vol. 2: Pp. viii+577–1297+plates 40–100. (London: Royal Horticultural Society, 1953.) Two volumes 42*s*. [169

British Productivity Council. Productivity Report: Fuel Conservation. Report of a visit to the U.S.A. in 1952 of a specialist team on the Conservation of Fuel, Heat and Energy. Pp. xii+102+8 plates. (London: British Productivity Council; Washington, D.C.: Office of Technical Services, Dept. of Commerce, 1953.) 5*s*. [179

Memoirs of the Royal Astronomical Society. New General Catalogue of Nebulæ and Clusters of Stars (1888); Index Catalogue (1895); Second Index Catalogue (1908). By Dr. J. L. E. Dreyer. Pp. iv+378. (London: Royal Astronomical Society, 1953.) 70*s*. (50*s*. to fellows.) [179

Cocoa: a Crop with a Future. By Paul Bareau. Pp. 39. (Bournville: Cadbury Brothers, Ltd., 1953.) 7*s*. 6*d*. [179

Other Countries

Queensland Institute for Medical Research. Seventh Annual Report, Year ended 30th June, 1952. Pp. 27. (Brisbane: Government Printer, 1953.) [119

South Australia. Institute of Medical and Veterinary Science. Fourteenth Annual Report of the Council, July 1951–June 1952. Pp. 89. (Adelaide: Government Printer, 1953.) [119

Indian National Scientific Documentation Centre. Report 1952–53. Pp. ii+13. (New Delhi: Indian National Scientific Documentation Centre, 1953.) [119

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1951. Pp. x+57. (Hyderabad-Dn.: Osmania University Press, 1953.) [119

Ceylon. Administration Report of the Acting Director of Fisheries for 1952. (Part IV—Education, Science and Art (L).) Pp. 26. (Colombo: Government Publications Bureau, 1953.) 50 cents. [119

East Africa High Commission. East African Fisheries Research Organization. Annual Report, 1952. Pp. v+42. (Jinja: East African Fisheries Research Organization, 1952.) [119

Indian Forest Records (New Series). Mycology, Vol. 1, No. 3: A New and Noteworthy Disease of Gamhar (*Gmelina Arborea* Linn.) due to *Poria Rhizomorpha* SP Nov. By K. Bagchee. Pp. 25–39+8 plates. (Delhi: Manager of Publications, 1953.) 1/4/– rupees: 2*s*. [119

Proceedings of the 11th International Congress of Philosophy. Vol. 5: Logic: Philosophical Analysis, Philosophy of Mathematics. Pp. 225. 17*s*. Vol. 6: Philosophy and Methodology of the Sciences de la Nature. Pp. 268. 21*s*. Vol. 14: Additional volume and Contributions to the Symposium on Logic. Pp. 350. 23*s*. (Amsterdam: North-Holland Publishing Company, 1953.) [119

Report on the Scientific Results of the "Michael Sars" North Atlantic Deep-Sea Expedition, 1910. Vol. 4, Part 2, No. 3: Synentognathi, Solenichthyes, Anacanthini, Berycomorphi, Xenoberyces from the "Michael Sars" North Atlantic Deep-sea Expedition, 1910. By Einar Koefoed. Pp. 38+4 plates. (Bergen: Trustees of the University of Bergen, 1953.) [119

United States Department of Agriculture. Leaflet No. 337: Bed Bugs: How to Control Them. Pp. 8. (Washington: Government Printing Office, 1953.) 5 cents. [179

United States Department of Agriculture. Bureau of Entomology and Plant Quarantine: Agricultural Research Administration. Grasshopper Control. Prepared by J. R. Parker and F. T. Cowan. Pp. 8. (Washington: Government Printer, 1953.) [179

Journal of the Institute of Polytechnics, Osaka City University. Series B, Physics. Vol. 1, No. 1. (February, 1950.) Pp. 31. (Osaka: Institute of Polytechnics.) [179

Australian National Antarctic Research Expeditions Reports. Series D: Meteorology. Vol. 2: Heard and Macquarie Islands, 1949. Pp. viii+135. Series D: Meteorology. Vol. 3: Heard and Macquarie Islands, 1950. Pp. x+142. (Melbourne: Antarctic Division, Dept. of External Affairs, 1953.) [179

Rubber Research Institute of Malaya, Kuala Lumpur. Annual Reports for 1949–50 of the Chemical Division. Pp. 33+23. (Kuala Lumpur: Rubber Research Institute of Malaya, 1953.) [179

Commonwealth Scientific and Industrial Research Organization, Australia. Soil Publication No. 1: Pedology of the Deniboota Irrigation District, New South Wales. By E. J. Johnston. Pp. 92. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) [179

l'Institut Météorologique Danois. Communications Magnétiques, etc. No. 21: The Lunar-Diurnal Variation of the Magnetic Declination in Rude Skov 1908–1951. By J. Egedal. Pp. 17. (København: I Kommission Hos G. E. C. Gad, 1953.) [179

Publications de l'Institut National pour l'Étude Agronomique du Congo-Belge. Série Technique No. 42: Recherches sur une plante à fibres: *L'Abroma augusta* L.f. Par. J. Capot, Prof. D. de Meulemeester, J. Brynaert et G. Raes. Pp. 113+23 plates. (Bruxelles: l'Institut National pour l'Étude Agronomique du Congo Belge, 1953.) 100 francs. [179

Fisheries Research Board of Canada. Progress Reports of the Atlantic Coast Stations (No. 56). Pp. 27. (Halifax, N.S.: Fisheries Research Board of Canada, 1953.) [179

Stanford University Publications: University Series. Biological Sciences, Vol. 11: Current Biological Research in the Alaskan Arctic. Edited by Dr. Ira L. Wiggins. Pp. viii+55. (Stanford, Calif.: Stanford University Press; London: Oxford University Press, 1953.) 1 dollar. [179

Bulletin of the Illinois Natural History Survey. Vol. 26, Article 1: The Mayflies, or Ephemeroptera of Illinois. By B. D. Burks. Pp. vi+216. (Urbana, Ill.: Illinois Natural History Survey, 1953.) [179

United States Department of Agriculture: Bureau of Agricultural Economics. Trade in Horticultural Specialties: a Statistical Compendium (1890–1950). By W. Truman Fossum. Pp. vi+116. (Washington: Government Printing Office, 1953.) [179

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